A

AMENDMENT AGREEMENT

BETWEEN:

UNION PACIFIC RAILROAD COMPANY, a corporation having a place of business at 1416 Dodge Street, Omaha, NE 68179, USA

(hereinafter referred to as "UP")

AND:

RAILPOWER TECHNOLOGIES CORP., a Canadian company having a place of business at Suite 202, 50 Fell Avenue, North Vancouver, British Columbia, Canada V7P 3S2

(hereinafter referred to as "RAILPOWER")

WHEREAS UP and RAILPOWER entered a Demonstration Lease Agreement dated November 30, 2001 (the "Lease") and now wish to amend its terms;

IN CONSIDERATION of good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the parties agree as follows:

1. Subsection 2.2 of the Lease is amended to extend the period of the Lease until and including June 30, 2003 and for use wherever in the USA UP designates.

2. Notwithstanding Section 3.1 of the Lease no amounts are payable by UP with respect to use during the quarter September 1, 2002 to December 31, 2002 provided costs as provided in Section 3.1 will be payable for the period January 1, 2003 to June 30, 2003.

3. Except for the foregoing all other provisions, terms and conditions in the Lease shall remain in full force and effect.

IN WITNESS WHEREOF the parties have executed this Agreement with effect this 17th day of January 2003.

UNION PACIFIC RAILROAD COMPANY

Per: _____
Nicolas Krajicek
Manager of Purchasing/Leasing

RAILPOWER TECHNOLOGIES CORP.

Per: _____
Gerard Koldyk
President & CEO

COPY

DEMONSTRATION LEASE AGREEMENT dated November 30, 2001.

BETWEEN UNION PACIFIC RAILROAD COMPANY, a corporation having a place of business at 1416 Dodge Street, Omaha, NE 68179, USA (hereinafter referred to as "UP")

AND RAILPOWER TECHNOLOGIES CORP., a British Columbia company having a place of business at 1118-777 Dunsmuir Street, Vancouver, British Columbia, Canada V7Y 1K4, (hereinafter referred to as "RAILPOWER")

WHEREAS:

A. RAILPOWER has designed and built a hybrid power switcher locomotive known as the "Green Goat", manufactured a demonstrator whose locomotive reporting marks are RPRX 2001 and patented same;

B. UP is an operating freight railroad that uses switchers and wishes to evaluate the suitability and business case of the Green Goat in actual freight railway field conditions;

C. Commercial demonstration needs to be undertaken to confirm various factors of the features and benefits of the Green Goat in order to validate the business case for UP future needs;

This Agreement sets forth the mutual agreement of the parties as follows:

1. SCOPE AND PURPOSE

1.1 The purpose of this agreement is to establish the principles upon which UP and RAILPOWER will demonstrate the Green Goat yard switcher,

1.2 Nothing in this agreement shall commit UP in any manner to purchasing any locomotives or other services from RAILPOWER. Should any such transaction arise from this demonstration, the parties will execute new agreements to replace this agreement.

2. ACTION PLAN

2.1 In order to further define the evaluation program the following are the intended steps:

(a) UP sent a Representative to Vancouver on October 4, 2001,

(b) The UP Representative and RAILPOWER will agree on conditions precedent for acceptance for delivery by UP of the Green Goat demonstrator. These terms shall be signed by both parties and attached to

this agreement as Appendix "A" and when attached shall form a part of this agreement;

2.2 UP and RAILPOWER shall determine a demonstration and longevity protocol that meets the requirement of UP for evaluation as well as RAILPOWER's additional requirements. When complete and signed by both parties it will be labelled Appendix "B" and when attached to shall form part of this agreement. While Appendix "B" will define the demonstration the following items will be addressed:

(i) confirmation of the location as Roseville, California, USA or arrangement of alternate site;

(ii) procedure to confirm tractive effort;

(iii) methodology for RAILPOWER personnel to interact and interface with the demonstration;

(iv) confirmation of the demonstration lease period as a minimum of six months and maximum of one year ;

(v) update the business case for the Green Goat including new technical and operating cost data;.

(vi) provision for loan to Pacific Harbor Lines in California for one month.

3.COSTS

3.1 For each available day of service UP will pay to RAILPOWER the sum of US$ 200. "Available day of service" shall mean when the locomotive is available to UP, not in for maintenance and not out on loan. This will apply to the greater of the minimum lease period of six months or the period from delivery to UP in California to return of the Green Goat demonstrator to an interchange point acceptable to both UP and RAILPOWER.

3.2 UP shall pay the costs of fuel, lube oil and all other maintenance items while locomotive is being operated by UP,

3.3 RAILPOWER will pay for all maintenance caused by equipment or system failure,

3.4 All risk and liability arising from the use of the Green Goat demonstrator by UP, other than arising from defective design and/or manufacture by RAILPOWER or

caused by the negligence or misconduct of RAILPOWER, shall be for the account of UP and UP shall indemnify RAILPOWER therefore. The replacement cost for total loss shall be US$600,000.

3.5 RAILPOWER shall deliver the locomotive to UP at the beginning of the lease at the closest UP interchange point at RAILPOWER's expense. RAILPOWER to pay for all costs associated with moving locomotive to/from UP interchange points as well as all costs associated with moving locomotive through US-Canadian customs. RAILPOWER is also to maintain and provide as needed all customs documentation.. If at the end of the demonstration lease, the unit is returned to RAILPOWER, UP at their cost shall return it to an interchange point in the UP system as agreed by RAILPOWER and UP.

3.6 RAILPOWER will pay for the travel, salary and other costs of its staff to monitor, service, direct service and other matters as required.

4. CONFIDENTIALITY

4.1 Except as provided under this clause, each party shall disclose the results of this demonstration only to those employees and professional advisers (including lawyers, accountants and brokers) with a need to know, and shall keep the existence and subject matter of this agreement confidential and shall not make any public announcement or disclose to any third party without the prior consent of the other parties unless required by law or the Canadian Venture Exchange. The parties specifically agree that a mutually agreed news release announcing this agreement will be issued. All information disclosed between the parties for the purposes of negotiations and identified as proprietary shall be treated as confidential by the receiving party and protected with the same extent as it treats its own proprietary information. This restriction shall not apply to information that is:

(a) in the public domain;

(b) already lawfully disclosed without restriction by the disclosing party to a third party; or

(c) subsequently disclosed without restriction by the disclosing party to a third party.

4.2 By mutual agreement, RAILPOWER and UP will set up opportunities to demonstrate the Green Goat to press, environmental and other interested parties to showcase UP and RAILPOWER's commitment to superior operating economics and a cleaner environment.

5. GENERAL

COPY

5.1 This agreement constitutes the entire Agreement between the parties and supersede any prior negotiation, understandings, and agreements between the Parties respecting the subject matter hereof. Modifications to this agreement must be in writing and signed by duly authorized representatives of each party.

5.2 This agreement may not be assigned in whole or in part by either party without the prior written consent of the other.

5.3 This agreement shall be governed by the laws of California and the laws of the United States applicable therein.

IN WITNESS WHEREOF the parties have executed this agreement with effect on the date first above written

UNION PACIFIC RAILROAD COMPANY	**RAILPOWER TECHNOLOGIES CORP.**
per: Jacqueline R White	**per:**
Print Name: Jacqueline R. White	**Print Name:** George Kozik
Gen Director Purchasing	PRESIDENT

COPY

APPENDIX "A"

The following list of items must be performed to comply with FRA and Union Pacific Railroad requirements before delivery to UP for service:

- The MU plug boxes and the raised platform for the control stand will be painted in such a way as to be more easily recognizable as a trip hazard. This will be accomplished by painting them a dissimilar colour or with yellow striping.
- Ditch lights will be moved out to 60".
- Belt guard for diesel engine will be installed.
- Stencilling on brake cylinder for max allowable travel will be 6 ½".
- Stencilling on cab wall will be applied identifying the emergency brake valve handle.
- Rear coupler will be reworked so it may release properly.
- Rear coupler release handle will be checked and reworked if required to ensure it does not protrude in the stairwell.
- The letter "F" will be stencilled on front of locomotive along the side.
- Wheel Slip Buzzer, light, or other indicator will be installed.
- Electrical hazard warning labels will be applied. Warning labels on the battery compartment lids, electrical cabinet doors, inverter junction box, and air compressor control box saying "Danger High Voltage" or "Danger - " plus the rating of the voltage found in that compartment.
- Fuel shut off for diesel fired water heater will be applied such that when one of the emergency fuel shut off switches on the side of the locomotive or in the cab are pressed, the water heater will also shut down.
- Heat guard for water heater exhaust will be installed.
- If fumes from the batteries or water heater are uncomfortably noticeable in the cab, as determined by UP, RAILPOWER will take steps to correct.
- The Green Goat Locomotive with reporting marks RPRX 2001 will be properly registered in the AAR UMLER system.

- The locomotive will be drained of all fuel before shipping.
- Before ship, the locomotive trainline receptacles (MU) will be properly marked and disconnected. The batteries will have the final connectors removed (disconnected) and will be reconnected by Frank Donnelly in Roseville when the locomotive arrives.

B

RAILPOWER
Technologies Corp.

FOR IMMEDIATE RELEASE **TSX Venture Symbol: P**

RAILPOWER ANNOUNCES MOVE INTO COMMERCIALIZATION

VANCOUVER, British Columbia, June 27, 2003 – RailPower Technologies Corp., (TSX-V: P), a leader in specialized energy technology systems, announced today that it is now in position to take commercial orders for its hybrid switcher locomotives following completion of the trial of its 2,000 horsepower Green Goat hybrid switcher locomotive with Union Pacific Railroad.

"The trial with Union Pacific started in March, 2002, at Union Pacific's Roseville yard near Sacramento, California and then relocated to Union Pacific's facilities in Chicago in January of this year for cold weather testing and testing in a number of different applications. We consider the performance and durability of the Green Goat and the confirmation of our emissions reduction estimates, a considerable success. The Green Goat performed successfully in all applications in which it was used," said RailPower President and CEO, Jim Maier.

Based on feedback from, and the performance of the Green Goat during, the Union Pacific trial, RailPower designed and built a pre-production Green Kid locomotive which at 1,000 horsepower is primarily targeted at industrial switching yards. The initial Green Kid is in the final stages of commissioning at Southern Rail in New Westminster, BC.

"RailPower is in advanced discussions with a number of potential customers and we continue to receive a growing number of expressions of interest. Accordingly, RailPower has taken the decision to move ahead with a production run of two additional Green Kid locomotives and two pre-production Green Goats. These locomotives will be used to fulfill anticipated initial orders, and to provide additional demonstration locomotives to help convert expressions of interest into firm orders. The pre-production Green Goats will also enable us to finalize manufacturing processes and procedures for the Green Goat," said Maier.

"I wish to conclude my remarks by saying how grateful we are to Union Pacific for their support during the Chicago and California tests. The depth of the working relationship that we now have with Union Pacific is very positive," concluded Maier.

As announced in May, the existing Green Goat is currently being moved from Chicago to the Los Angeles area for a 30-day trial with Pacific Harbor Line, commencing mid-July.

RailPower's Green Goat (2,000 h.p.) and the smaller Green Kid (1,000 h.p.) feature small, Tier 2 compliant diesel generators and very large, long-life, recyclable battery banks. Both have very low maintenance requirements, high reliability and offer a number of safety features, including improved visibility. They reduce smog-precursor NOx and dangerous diesel particulate emissions by 80-90%. Diesel fuel consumption is reduced by at least 50%, when compared to a late model conventional yard switching locomotive of comparable power.

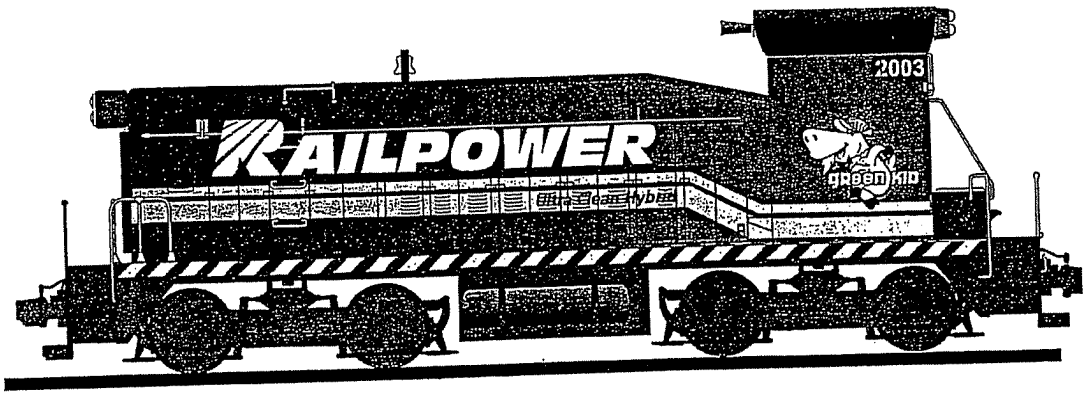
About RailPower
RailPower Technologies Corp. (www.railpower.com) is a leader in specialized energy technology systems for transportation and power generation. In addition to its patented locomotive technologies, it has a patent pending in respect of its rDirect power conditioning technology for distributed and remote power generation technologies.

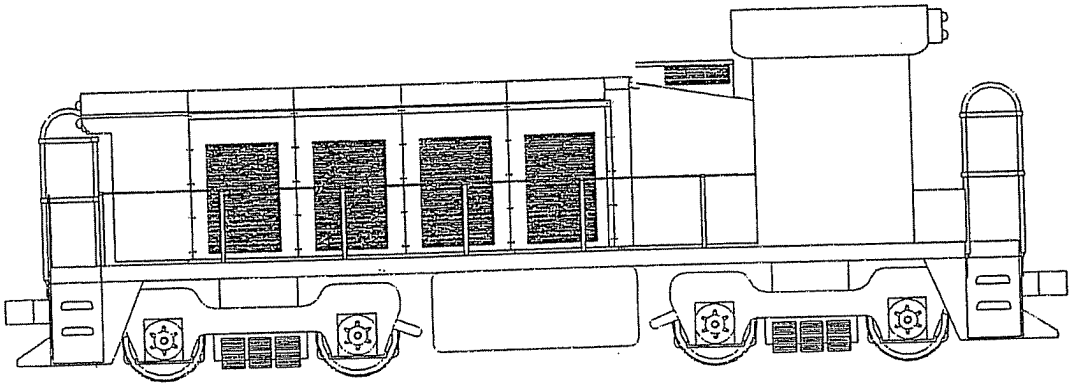
For more information, please contact:
Simon Clarke
Executive Vice President, Corporate Development
RailPower Technologies Corp.
(604) 904-0085 ext.206 phone
(604) 904-1186 fax
e-mail: sclarke@railpower.com

Jay Hussey
Investor Relations
The Equicom Group Inc.
(416) 815-0700 ext. 225 phone
(416) 815-0080 fax
e-mail: jhussey@equicomgroup.com

RAILPOWER
Technologies Corp.

The Green Kid Remote Control





Specifications

Traction Horsepower	1,000 HP
Starting Tractive Effort	60,000 lbs
Maximum Speed (w/o field shunting)	15 mph
Max Weight	248,000 lbs
Gear Ratio	62/15
Brake	26L
Traction Motor	D77

Dimensions

Overall Length	44' 5"
Overall Height	14' 6 ½"
Overall Width	10' 2"
Two Remote Safety Booths	24" x 19" x 84"

Supplies

Fuel Capacity	600 US gal
Sand Capacity	24 cu. ft.

Battery Bank

Maintenance Free Lead Acid Battery	
Voltage	345 V
Capacity	1500 AH
Target Life	10 years

Features

- 50% - 80% reduction in fuel usage
- 80% - 90% reduction in NO_x emissions
- Instant response from the power stored in the batteries
- Automatic energy management by onboard computer
- Remote controlled
- Low engine noise
- Automatic traction motor isolation when grounds are detected
- Individual wheel slip control for maximum possible tractive effort
- Low maintenance engine requires only annual inspection and service
- 240 and 120 VAC available on board
- 12 and 300 VDC available on board

Gen - Set

Make	Isuzu 4BG1T 98 MP Diesel
Output	50 kW

Air Compressor

Make	Rotorcomp NK-100G-30 T Rotary Screw
Output	90 cfm @150 psi

Remote Control

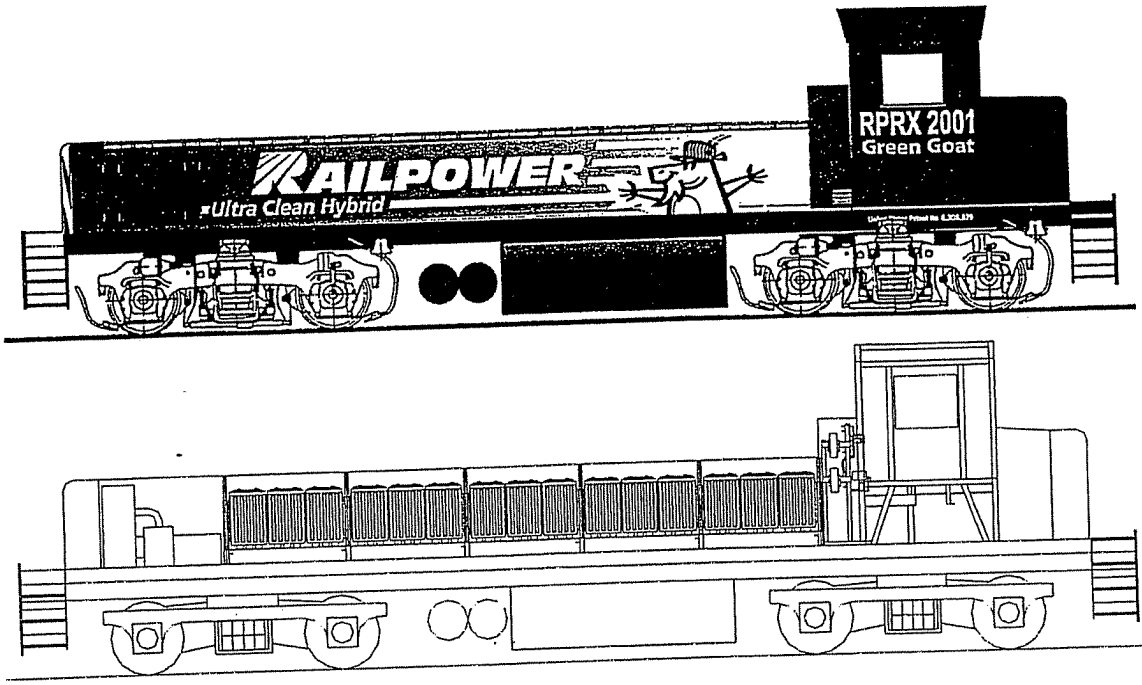
Spread Pectrum Class II

Updated June 10, 2003

* Specifications Subject To Change

RAILPOWER
Technologies Corp.

The Green Goat - Hybrid Yard Switcher



Specifications

Traction Horsepower	2,000 HP
Starting Tractive Effort	87,000 lbs
Maximum Speed (w/o field shunting)	20 mph
Max Weight	280,000 lbs
Gear Ratio	62/15
Brake	26L

Dimensions

Overall Length	52' ½"
Overall Height	14' 6"
Overall Width	10' 6"

Supplies

Fuel Capacity	2100 US gal
Sand Capacity	36 cu. ft.
Battery	1000 kWh

Battery Bank

Maintenance Free Lead Acid Battery	
Voltage	600 V
Capacity	1200 AH
Target Life	10 years

Features

- 50% - 80% reduction in fuel usage
- 80% - 90% reduction in NO_x emissions
- Instant response from the power stored in the batteries
- Automatic energy management by onboard computer
- AAR control stand for operator familiarity
- High visibility in all directions because of the low, long hood
- Low engine noise
- Automatic traction motor isolation when grounds are detected
- Heated glass for working in cold climates
- Framed windows for easy change out
- Anti-climbers for head on collision protection
- Internal cab roll cage for roll-over protection
- Individual wheel slip control for maximum possible tractive effort
- Low maintenance engine requires only annual inspection and service
- 480 and 120 VAC available on board
- 24, 74, and 600 VDC available on board
- 33,000 BTU cab cooling
- 13.5 kW cab heating

Gen - Set

Make	Isuzu / Marathon
Output	90 kW

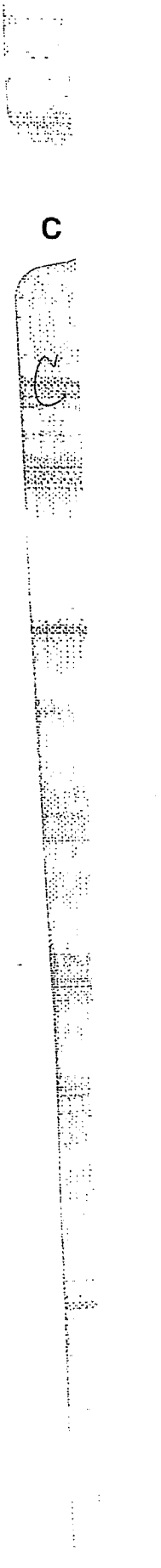
Air Compressor

Make	Rotary Screw
Output	120 cfm @125 psi

The Green Goat is an electric hybrid switcher that makes use of a diesel engine and energy storage to allow it to offer a 30% to 45% reduction in fuel savings during yard switching operations while at the same time being quieter and producing 80% to 90% less NO_x. Energy produced by the generator is stored in the batteries making the Green Goat able to respond instantly to the commands of the operator. Also of benefit to the operator is its low long hood offering great visibility through heated glass from a cab that offers air conditioning and heating and an engine that makes very little noise.

Updated June 10, 2003

* Specifications Subject To Change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RAILPOWER Technologies Corp.

Suite 202, 50 Fell Avenue
North Vancouver, BC V7P 3S2
Phone: (604) 904-0085
Fax: (604) 904-1186
http://www.railpower.com

RAILPOWER HYBRID LOCOMOTIVE FOR L.A. TRIAL.

VANCOUVER, CANADA, May 23, 2003 – RailPower Technologies Corp. ("RailPower") (TSX Venture - P) announced today that it has signed an agreement with Pacific Harbor Line, Inc. ("PHL") to test a Green Goat™ hybrid locomotive in the Los Angeles area, starting in July, 2003 for a 30 day period.

"The intention of this trial is to test the Green Goat under normal PHL commercial working conditions, prior to a possible order for Green Goat locomotives from PHL," stated Jim Maier, RailPower President and CEO. "We are delighted to be able to demonstrate the Green Goat's ability to substantially reduce emissions in the Los Angeles area where there is a large focus on emissions reducing technologies."

RailPower hybrid locomotives feature a small diesel generator and a very large, long-life battery bank. These locomotives reduce smog-precursor NOx and diesel particulate emissions by 80-90%, and recent tests indicate that diesel fuel consumption is reduced by at least 50%, when compared to a late model conventional yard switching locomotive of comparable power.

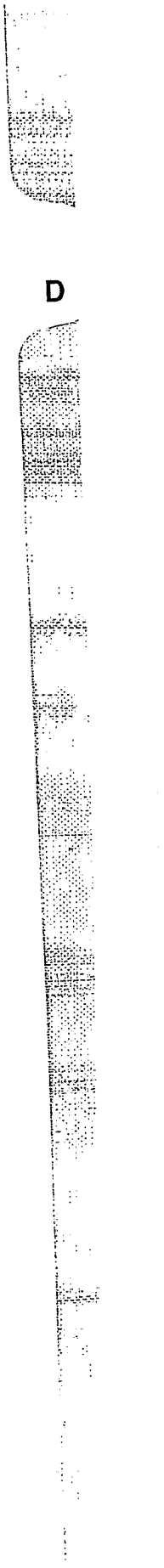
PHL is a subsidiary of Anacostia Rail Holdings, Inc. ("Anacostia"), one of the leaders in the development of modern short line railroads in the U.S. (www.anacostia.com). Anacostia has developed eight new U.S. railroads since it was founded in late 1985. PHL provides railroad-switching services to customers in the Ports of Long Beach and Los Angeles. It also dispatches all Burlington Northern & Santa Fe and Union Pacific trains within these ports.

"Environment and community stewardship is one of the key cornerstones by which we do business," said Peter A. Gilbertson, Anacostia President & CEO. "The Green Goat Demonstration Lease is the latest in a series of initiatives undertaken by Pacific Harbor Line to reduce emissions from its locomotives. We believe that the Green Goat has the potential to offer a compelling combination of reduced emissions, noise pollution and overall operating costs. This trial will be an invaluable opportunity for both parties to see the Green Goat performing under real port conditions at our Pacific Harbor Line's facilities."

RailPower Technologies Corp. (www.railpower.com) is a leader in specialized energy technology systems for transportation and power generation. In addition to its patented locomotive technologies, it has a patent pending in respect of its rDirect power conditioning technology for distributed and remote power generation technologies.

The TSX Venture Exchange has not reviewed and does not accept responsibility for the adequacy or accuracy of this release.

Contact: Simon Clarke, RailPower Technologies 604 904 0085 ext. 206 sclarke@railpower.com
Jay Hussey, Investor Relations, 1-800-385-5451 ext. 225 jhussey@equicomgroup.com
Andrew C. Fox, Pacific Harbor Line 310 834 4594
Peter A. Gilbertson, Anacostia Rail Holdings 312 341 1026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RAILPOWER Technologies Corp.

Suite 202, 50 Fell Avenue
North Vancouver, BC V7P 3S2
Phone: (604) 904-0085
Fax: (604) 904-1186
http://www.railpower.com

GREEN GOAT'S UP TRIAL EXTENDED TO JUNE 30, 2003. NEW DEMO IN CHICAGO

VANCOUVER, CANADA, January 17, 2002 – RailPower Technologies Corp. ("RailPower") (TSX Venture - P) announced today that the demonstration trial of its Green Goat hybrid locomotive with the largest railroad in the US, the Union Pacific ('UP'), has been extended by a signed agreement today to June 30, 2003.

The extension is to facilitate testing of the emissions-reducing locomotive at the UP's Proviso switch yards in Chicago. The Green Goat has been at the UP's Roseville switch yards near Sacramento since early March 2002.

"The Green Goat is anticipated to arrive in Chicago in about five days' time. It has been modified to take account of the anticipated colder working conditions there," said Frank Donnelly, Chief Technology Officer.

"We are excited at the prospect of being able to demonstrate the Green Goat's technological advantages over conventional switchers in what is one of the major railroad cities in the US."

The Chicago trial will have the Green Goat 'instrumented' to confirm internal data which shows that it gets a minimum of 30% fuel savings and 80-90% reductions in smog-precursor NOx and particulate emissions said Donnelly.

RailPower Technologies Corp. (www.railpower.com) is a leader in specialized energy technology systems for transportation and power generation. In addition to its patented mainline and switcher locomotive technologies, it is developing rDirect power conditioning technology for distributed and remote power generation technologies such as micro-turbines.

The TSX Venture Exchange has not reviewed and does not accept responsibility for the adequacy or accuracy of this release.

Contact: Simon Clarke, 604 904 0085 extension 206 sclarke@railpower.com

E

RAILPOWER Technologies Corp.

Suite 202, 50 Fell Avenue
North Vancouver, BC V7P 3S2
Phone: (604) 904-0085
Fax: (604) 904-1186
http://www.railpower.com

RAILPOWER UPDATE

VANCOUVER, CANADA, October 11, 2002 – RailPower Technologies Corp. ("RailPower") (TSX Venture - P) has started construction of the Green Kid at Southern Rail in Burnaby, British Columbia. The Green Kid is a smaller hybrid locomotive than the Green Goat. While the Green Goat is designed for full yard service and is capable of 2,000 horsepower, the Green Kid has been designed for a less demanding duty cycle where a power rating of up to 1,000 horsepower is sufficient. The Green Kid is largely targeted at industrial operators such as grain terminals, chemical plants, port authorities etc. which use switching locomotives to move product from their facilities to the main line. The Green Kid will be fully equipped with remote control, which is being developed and installed by Railpower.

Simon Clarke, Executive Vice President of RailPower, stated. "The cost savings, efficiencies and cleaner emissions of the Green Kid compared to traditional industrial switching locomotives are very persuasive to industrial operators. We believe that there are substantial opportunities for this locomotive in industrial operations across North America in what is a significant market within the switching industry. Indeed, the Green Kid is already starting to generate significant interest from local industrial operators in and around Vancouver with several expressing strong interest in leasing this unit. A further announcement will be made once a lease is finalized". Construction of the Green Kid will be complete early in 2003.

RailPower's Green Goat is more than halfway through its demonstration lease with Union Pacific Railroad ("Union Pacific"). While a number of issues, including thermal management issues, arose during the early part of the trial, these have been addressed to enable the Green Goat to successfully perform up to three shifts per day in yard service depending on Union Pacific's daily requirements. RailPower is also using the trial to size and upgrade a number of key components to ensure that the potential of the Green Goat design is fully maximized. This process is currently underway; it is being done with minimal interruption to the trial and is expected to be completed shortly.

The Green Goat has been well received by the operators in Union Pacific's Roseville Yard. The trial is now moving into the phase of validating and documenting the precise fuel savings and emissions reduction of the Green Goat compared to existing diesel electric switching locomotives fitted with auto shut-off devices to reduce idling. Preliminary internal studies by RailPower confirm its

own conservative estimates that the Green Goat will provide fuel savings of a minimum of 30% and will cut NO_x and diesel particulates by 80%-90%. A formal testing schedule will be implemented with Union Pacific and RailPower is confident that this will fully validate its own internal results.

RailPower has also opened a new Tech Centre in North Vancouver, while maintaining its existing project office at Southern Rail in Burnaby. This new space allows RailPower to assemble and manufacture some of the key components for the Green Goat and Green Kid thereby controlling the supply of key components for the manufacturing process. Final assembly of the key components onto locomotive frames will be completed at the facilities of RailPower's contract manufacturing partners.

Negotiations are ongoing with potential manufacturing partners for volume manufacture of the Green Goat. These potential manufacturers are large international companies with the capability and capacity to manufacture Green Goats in the volume anticipated. An announcement will be made once a manufacturing partner for the Green Goat has been finalized.

RailPower Technologies Corp. is a leader in specialized energy technology systems for transportation and power generation. In addition to its patented mainline and switcher locomotive technologies, it is developing rDirect power conditioning technology for distributed and remote power generation technologies such as micro-turbines.

The TSX Venture Exchange has not reviewed and does not accept responsibility for the adequacy or accuracy of this release.

Contact: Simon Clarke, 604 904 0085 extension 206 sclarke@railpower.com

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RAILPOWER Technologies Corp.

P.O. Box 10443
Vancouver, BC,
Canada. V7Y 1K4
TEL: (604) 687-8470
FAX: (604) 608-6734
gkoldyk@railpower.com

US RAILROAD GIANT UNION PACIFIC LEASES 'GREEN GOAT™' HYBRID SWITCHER LOCOMOTIVE FOR CALIFORNIA.

VANCOUVER, CANADA, JANUARY 8, 2002 - The largest railroad in the US, Union Pacific Railroad, an operating subsidiary of Union Pacific Corporation (NYSE: UNP), has signed a 1-year demonstration lease for RailPower Technologies Corp.'s (CDNX: P) 'Green Goat™', it was announced today. The hybrid yard switcher locomotive will be based at UP's yards in Roseville, near Sacramento, California.

Michael E. Iden, General Director, Car and Locomotive Engineering, Union Pacific Railroad, said, "UP is constantly looking at ways to operate more cost effectively and to improve the environment by reducing locomotive exhaust emissions. The Green Goat switcher offers the opportunity for substantial operating cost advantages through lower fuel usage, lower maintenance and higher productivity. Union Pacific has looked at several options for replacing our aging switcher fleet and the Green Goat has the strong advantage of having a capital cost that makes sense to the railroad for a 20-year solution. Importantly, it also has no impact on our fueling infrastructure as both its two generator modalities -conventional engine and microturbine – use standard diesel fuel."

RailPower President, Gerard Koldyk, stated, "The Green Goat was created to provide a long term superior economic solution for yard switching that would also meet and exceed all the existing and contemplated North American emissions requirements for the railroads. Our strategy is to focus on the immediate markets of environmental sensitivity in California, Texas and New York and then broaden out to general fleet operations and industrial applications."

Koldyk said the Green Goat 's development has been timely. "The switcher fleet is aging and major railroads are looking at a 20-year answer that is economically sound and solves all environmental concerns. Considerable interest has been generated in the Green Goat. We are priced very competitively. We have the performance and, perhaps most important of all, we have a technology that will deliver operating cost savings we believe will be in excess of 30% compared to conventional switchers. This is RailPower's final stage of its Green Goat R & D and we are encouraged by UP's financial commitment to the program."

RailPower Technologies Corp., of Vancouver, Canada, is a leader in specialized energy technology systems for transportation and power generation. In addition to its patented mainline and switcher locomotive technologies, it is developing rDirect power conditioning technology for distributed and remote power generation technologies such as microturbines.

Union Pacific Corporation is one of America's leading transportation companies. Its principal operating company, Union Pacific Railroad, is the largest railroad in North America, covering 23 states across the western two-thirds of the United States. With competitive long-haul routes between all major West Coast ports and eastern gateways, and as the only railroad to serve all six gateways to Mexico, UP has the premier rail franchise in North America.

Contact: Gerard Koldyk, RailPower 604 687 8415.
John Bromley, UP 402 271 3475

RAILPOWER
Technologies Corp.

P.O. Box 10443
Vancouver, BC,
Canada. V7Y 1K4
TEL: (604) 687-8470
FAX: (604) 608-6734
gkoldyk@railpower.com

US RAILROAD GIANT UNION PACIFIC LEASES 'GREEN GOAT™' HYBRID SWITCHER LOCOMOTIVE FOR CALIFORNIA.

VANCOUVER, CANADA, JANUARY 8, 2002 - The largest railroad in the US, Union Pacific Railroad, an operating subsidiary of Union Pacific Corporation (NYSE: UNP), has signed a 1-year demonstration lease for RailPower Technologies Corp.'s (CDNX: P) 'Green Goat™', it was announced today. The hybrid yard switcher locomotive will be based at UP's yards in Roseville, near Sacramento, California.

Michael E. Iden, General Director, Car and Locomotive Engineering, Union Pacific Railroad, said, "UP is constantly looking at ways to operate more cost effectively and to improve the environment by reducing locomotive exhaust emissions. The Green Goat switcher offers the opportunity for substantial operating cost advantages thrcugh lower fuel usage, lower maintenance and higher productivity. Union Pacific has looked at several options for replacing our aging switcher fleet and the Green Goat has the strong advantage of having a capital cost that makes sense to the railroad for a 20-year solution. Importantly, it also has no impact on our fueling infrastructure as both its two generator modalities -conventional engine and microturbine – use standard diesel fuel."

RailPower President, Gerard Koldyk, stated, "The Green Goat was created to provide a long term superior economic solution for yard switching that would also meet and exceed all the existing and contemplated North American emissions requirements for the railroads. Our strategy is to focus on the immediate markets of environmental sensitivity in California, Texas and New York and then broaden out to general fleet operations and industrial applications."

Koldyk said the Green Goat 's development has been timely. "The switcher fleet is aging and major railroads are looking at a 20-year answer that is economically sound and solves all environmental concerns. Considerable interest has been generated in the Green Goat. We are priced very competitively. We have the performance and, perhaps most important of all, we have a technology that will deliver operating cost savings we believe will be in excess of 30% compared to conventional switchers. This is RailPower's final stage of its Green Goat R & D and we are encouraged by UP's financial commitment to the program."

RailPower Technologies Corp., of Vancouver, Canada, is a leader in specialized energy technology systems for transportation and power generation. In addition to its patented mainline and switcher locomotive technologies, it is developing rDirect power conditioning technology for distributed and remote power generation technologies such as microturbines.

Union Pacific Corporation is one of America's leading transportation companies. Its principal operating company, Union Pacific Railroad, is the largest railroad in North America, covering 23 states across the western two-thirds of the United States. With competitive long-haul routes between all major West Coast ports and eastern gateways, and as the only railroad to serve all six gateways to Mexico, UP has the premier rail franchise in North America.

The Canadian Venture Exchange has not reviewed and does not accept responsibility for the adequacy or accuracy of this release.

Contact: Gerard Koldyk, RailPower 604 687 8415.
John Bromley, UP 402 271 3475

RAILPOWER Technologies Corp.

777 Dunsmuir Street
Suite 1118
P.O. Box 10443
Vancouver, BC
Canada V7Y 1K4
Tel: (604) 687-8470
Fax:(604) 608-6734

RAILPOWER UPDATES PROGRESS

VANCOUVER, CANADA, SEPTEMBER 12, 2001— RailPower Technologies Corporation (P-CDNX) has successfully demonstrated its Green Goat hybrid switcher in public for the first time. The world's largest hybrid freight switcher locomotive ran at Southern Railways' yards in New Westminster, British Columbia.

President and CEO, Gerard Koldyk said "The unique Green Goat performed up to all our expectations before media, industry officials and engineering inspectors. Now we aim to conclude an agreement with a Class 1 railroad company as soon as possible to enter commercial testing."

The company is moving from research and development to commercialization. The Green Goat will be built by one of the several subcontractors RailPower has been in discussions with. In conjunction, the following management changes will be made, effective October 9, 2001, Gerard Koldyk will be the President and CFO and Frank Donnelly will become the Chief Technology Officer and CEO. The current CFO and Controller, Alain Voisin, will remain as Controller.

The Tech Centre and head office will be combined into one facility, resulting in the reduction of two research engineers. Electrical research and development work and locomotive maintenance will be done in this new center as well as facilities in the USA and Canada near our customers.

Koldyk said the Memorandum of Understanding with RailPower's potential prime mover partner is unlikely to result in any agreement before expiry due to key staff leaving at the potential partner and the general state of financial markets. The financing previously announced on July 30th, 2001 is delayed until financial markets improve.

"With the changes mentioned above, RailPower is well positioned to commence and complete the commercial testing of the Green Goat, accept orders and have them contract manufactured. In addition, the company will maintain current research and development on rDirect power, a key component of the CINGL

locomotive which also has markets in distributed power and similar applications," continued Koldyk. "The company has sufficient resources to continue these activities for an estimated two years in the unlikely event no sales occur before that time."

The Canadian Venture Exchange has not reviewed and does not accept responsibility for the adequacy or accuracy of this release.

Contact: Nigel Horsley, 604 687 8470. www.railpower.com nigel@railpower.com

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Union Pacific Railroad Testing Experimental Locomotive in Chicago

Omaha, Neb., March 12, 2003 – Union Pacific Railroad is testing a hybrid, battery-powered locomotive called the "Green Goat" in its Chicago railyards to determine if it is a feasible alternative to conventional diesel-electric locomotives.

"The Green Goat test is an opportunity for us to try a novel technological approach in our never-ending search for an alternative fuel for locomotives," said Mike Iden, Union Pacific's general director - car and locomotive engineering.

"This locomotive could also reduce the emissions of nitrogen oxides, or NOx, by as much as 90 percent, when compared to current diesel-fueled locomotives, " Iden added.

"Hybrid power technology has already demonstrated, in automotive applications, its ability to perform more economically and reduce emissions. The Green Goat locomotive, we believe, can provide a similar opportunity for the railroads, but at a comparatively better economic entry point than was initially experienced by the automotive industry," said Frank Donnelly, Chief Technology Officer, RailPower Technologies Corp., manufacturer of the hybrid locomotive.

The railroad has been testing this locomotive in its railyard at Roseville, Calif., since March 2002. The locomotive was moved to Chicago for cooler weather testing in January 2003. Testing is scheduled to be completed in June 2003.

The batteries in this hybrid locomotive produce the same amount of energy as a locomotive powered by an electrical generator attached to a 2,000-horsepower diesel engine. A 2,000-horsepower locomotive is used primarily in railyards. Typically, 3,000 to 4,400-horsepower locomotives are used to pull trains between cities.

Union Pacific's comprehensive test of the hybrid battery-powered locomotive is evaluating the locomotive's emissions, performance, maintenance requirements and economic feasibility. The battery charging system is also being studied.

Throughout Union Pacific's 140-year history, the railroad has evaluated a variety of alternative fuels, or power

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TRAIN SCAN
Canadian Railway News

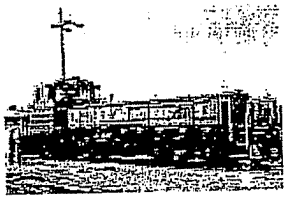
October 2001

The GREEN GOAT

Most switching locomotives in North America were built at least 30-40 years ago. Some are older road locomotives, generally four-axle, that have migrated into switching service as they are replaced by newer more capable power. While many have been rebuilt or modified during their lifetimes, they still all run on the same basic principle: prime mover turns generator to produce electric power for traction motors on the axles. At the same time, as economic conditions are driving railways to search for new efficiencies, they are coming under increasing scrutiny as far as production of greenhouse gasses and solid particulate air pollution are concerned.

Enter the **Green Goat.**

RailPower Technologies is a Vancouver company that is looking at new ways of increasing diesel locomotive efficiency. One of their ideas is the Green Goat which was rolled out for a demo in early September. This is a switching locomotive that is as revolutionary in its design as it is in its appearance.



The Green Goat is a hybrid switcher. That means the electric traction motors on the axles are powered by a large bank of custom-designed lead acid batteries. The batteries are kept charged by a small generator driven by a diesel prime mover. While the diesel only runs as required to keep the batteries to the desired state of charge, power is always available without delay from the batteries. Since the load of the diesel/generator doesn't vary -- it's always charging the same batteries -- during the periods when it is running, it runs at a constant speed, and thus can be tuned to be very efficient. The result compared to a conventional diesel-electric switcher is a much quieter and more efficient locomotive that produces much less pollution.

The Green Goat's appearance also sets it apart. The prototype is built on a conventional GP9 frame. Not only has the short hood been chopped, but the long hood as well, giving excellent visibility in all directions. The batteries take up the majority of the space under the long hood, with a small space left over for the prime mover and generator. Since the batteries are heavy, they provide the weight needed to give the locomotive good traction. The Green Goat looks somewhat like a slug or booster unit with a control cab; in fact it's a completely functional 2000 HP switching locomotive.

sources, for locomotives. They include wood, coal, fuel oil, diesel fuel and liquefied natural gas. Locomotive "technologies" also have changed from steam to diesel-electric and electric.

A "goat," in railroad slang, refers to a locomotive used in railyards.

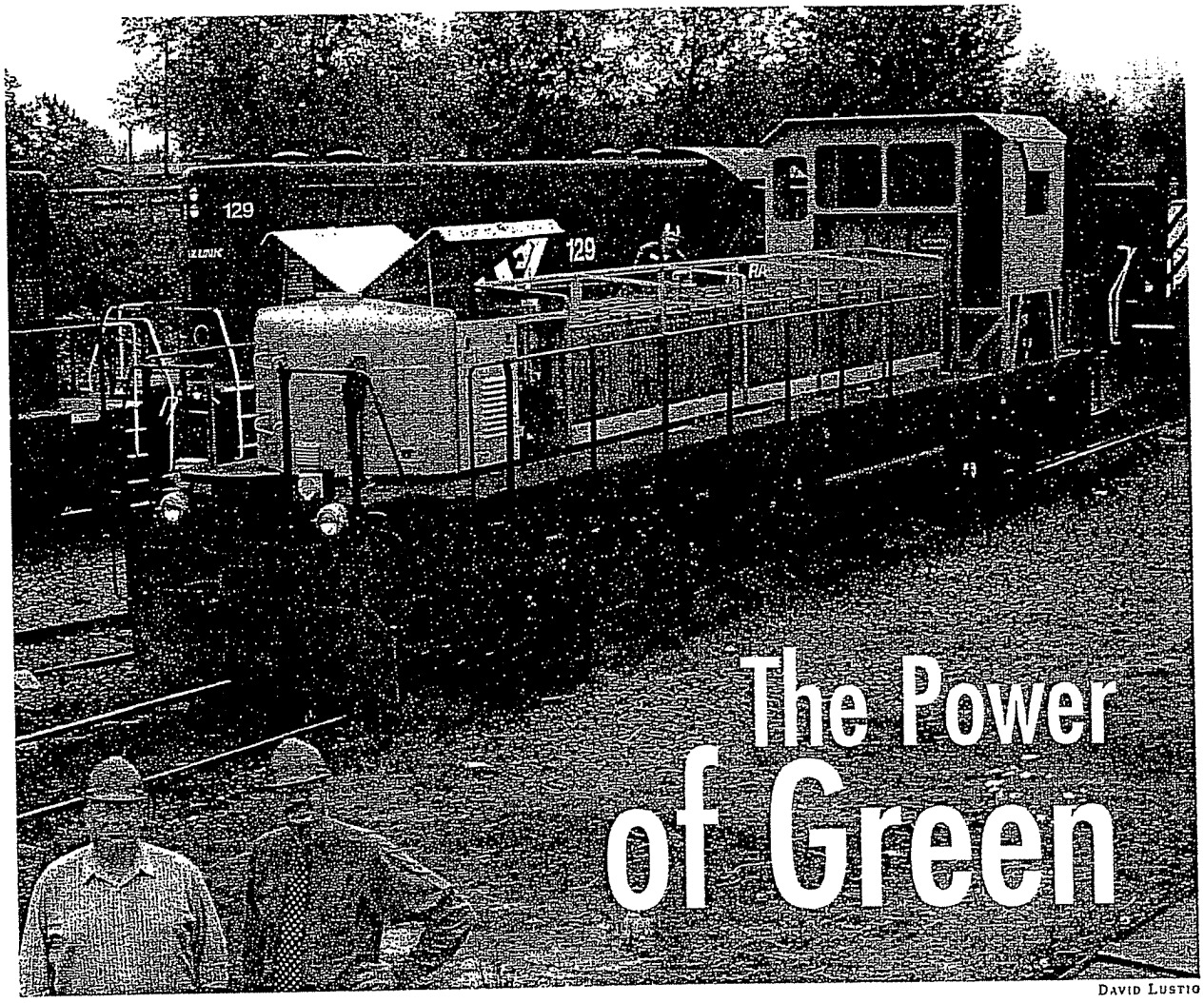
Union Pacific Corporation is one of America's leading transportation companies. Its principal operating company, Union Pacific Railroad, is the largest railroad in North America, covering 23 states across the western two-thirds of the United States. A strong focus on quality and a strategically advantageous route structure enable the company toserve customers in critical and fast growing markets. It is a leading carrier of low-sulfur coal used in electrical power generation and has broad coverage of the large chemical-producing areas along the Gulf Coast. With competitive long-haul routes between all major West Coast ports and eastern gateways, and as the only railroad to serve all six gateways to Mexico, Union Pacific has the premier rail franchise in North America. The Corporation's trucking operations include Overnite Corporation, which owns less-than-truckload carriers Overnite Transportation and Motor Cargo.

RailPower Technologies Corp., of Vancouver, Canada, is a leader in specialized energy technology systems for transportation and power generation. In addition to its patented mainline and switcher locomotive technologies, it is developing rDirect power conditioning technology for distribution and remote power generation technologies such as micro-turbines.

For further information, contact Mark Davis: (402) 271-5459

Green Goat Fast Facts (7K PDF file)

Green Goat Schematic (993K PDF file)
This graphics file is in a PDF format. Users need Illustrator, Adobe Acrobat Reader, Adobe Exchange or PhotoShop 5 to open PDF files.



The Power of Green

DAVID LUSTIG

RailPower's Frank Donnelly and Gerald Koldyk pose with their unfinished Green Goat prototype.

BY DAVID LUSTIG

THE COLOR GREEN usually evokes thoughts of money, or of concepts environmentally kind to Mother Earth. In that spirit, RailPower Technologies Corp. of Vancouver, British Columbia, wants you to meet "Green Goat," a 2000 h.p. yard switcher RPT expects will allow railroads to meet pollution requirements of the future.

RailPower claims Green Goat will achieve a 90% NOx emission reduction (Nitrogen Oxide, one of the ingredients in acid rain) compared with the existing best diesel-electric locomotives, while using less diesel fuel.

"The Green Goat is a very simple concept," said Frank Donnelly, RailPower's chief technology officer. "It's basically a hybrid vehicle. The energy is stored in 30 custom-designed, lead-acid 20-volt batteries, which supply 95 percent of the Goat's horsepower. The last five percent, about 100 horsepower, comes from an on-board micro-turbine, whose job is to supply a constant trickle charge to the batteries [when not called on to supply traction horsepower]." A micro-turbine is a very small gas turbine engine similar to those used in jet aircraft, in this case powered with diesel fuel.

"Switchers spend a very high percentage of their time in idle," Donnelly stated. "Only one percent of their daily life is in the eighth [throttle] notch, so this is an ideal application for hybrid vehicle technology." The locomotive, he said, meets the strictest current exhaust emissions standards in the U.S., and at the same time will reduce fuel consumption over a typical EMD GP9 in yard service by 35%.

The Green Goat project began in March 2000 when the company raised C$2 million to build the demonstrator. The demonstrator uses the frame and some other components from former Southern Pacific GP9 2890. Everything above the frame was discarded except for small parts of the front and rear noses, both of which were heavily modified. All other components—including the locomotive control stand, trucks, wiring, the 26L brake system, traction motors, and switch gear—were remanufactured and brought to the same tolerances as new equipment.

RailPower rolled out its demonstrator for TRAINS in July. At that time, completion was still weeks away, and little more than the custom-designed cab and batteries was in place above the frame. The Green Goat's shape is similar to a yard slug, but with a cab.

How go McCormack's PA's?

WHAT HAS HAPPENED to the two Alco PAs repatriated from Mexico since TRAINS reported on Doyle McCormack's PA project in January 2001? Plenty. Both units, which arrived from Mexico without trucks, now are back on trucks that TRAINS columnist Greg McDonnell helped locate, said McCormack. They look great. The trucks, manufactured for Fairbanks-Morse Erie-built, required modifications to the PAs' centercastings.

The PAs were scheduled to be moved in late August or early September from Albany, Ore., to the former Southern Pacific roundhouse at Brooklyn Yard in Portland, home of SP 4-8-4 4449 and SP&S 4-8-4 700. Besides being closer to the heavy equipment required to complete the restoration, the roundhouse will provide an ideal working environment for the remainder of the project. McCormack is enthusiastic: "I've already toasted them with a Pepsi," he said. — DAVID LUSTIG

The "long hood end" is considerably cut down because it does not need to house a tall diesel engine. Official rollout is anticipated in early September, to be followed by yard testing.

The Green Goat's first yard trials will be done with a 100 h.p. Daewoo diesel engine substituting for the micro-turbine. RailPower expects the tests to show if the unit requires the planned 100 h.p. turbine, or if a 50 h.p. turbine will be sufficient. The diesel used in the tests will not be available in production models.

The Green Goat is expected to have a top speed of 30 miles per hour, and it will be able to operate in multiple with any existing locomotive. Rail Power plans to offer the Green Goat in both cab and cabless models, the latter for remote-control operation.

Railroads that commented on the Green Goat project said they are interested in any innovative and environmentally sound motive-power designs. But they're also cautious.

"Before looking at any alternative design, we would have to review the performance characteristics relative to tractive effort, operating range, and any long- and short-term maintenance requirements regarding the batteries," said Union Pacific Chief Mechanical Officer Joe Santamaria.

"Obviously in some of our more congested areas, depending on the price of the locomotive, we might look at it as an alternative."

RailPower expects a 20-year lifespan for the Green Goat, with a midlife battery change after 10 years. Gerald Koldyk, president and CEO of RailPower, plans to offer his quiet, almost vibrationless switcher as a complete lease package, with RailPower responsible for all maintenance and repairs. He says RailPower is discussing the Green Goat with two U.S. Class 1 railroads, a regional carrier, and a terminal operator, but declined to name them until contracts are signed. The prototype Green Goat will cost the company all its initial funding. Production units should be available for under U.S.$1 million. Koldyk hopes to sell 20 to 50 Green Goats a year, and future concepts include a stretched Green Goat for commuter rail operations.

RailPower, headquartered in downtown Vancouver has its engineering plant is in the former blacksmith shop of Southern Railway of British Columbia (a sister road to Montana Rail Link) in nearby suburban New Westminster. RailPower has only seven employees; it will subcontract production to an existing locomotive builder.

Notes on Numbers

The late David P. Morgan, longtime TRAINS editor, was known for his ability to write with conciseness.

When Kalmbach Publishing Co. was in its previous offices at 1027 N. 7th Street in Milwaukee, readers regularly sent to TRAINS photos of locomotives and rolling stock that bore the digits of the famous (to readers) address.

When I was working for a now-defunct competing railroad magazine, I ran a photo of a Southern Pacific Alco S3 switcher wrecked in a collision; its number was 1027. About a week after publication, a letter came from Morgan. The body of the letter had only word: "Ouch!" ℐ

REPORT ON BUSINESS

CANADA'S BUSINESS NEWSPAPER • FOUNDED 1962 • GLOBEANDMAIL.COM • MONDAY, MAY 27, 2002

JOHN DECKER/THE GLOBE AND MAIL

In RailPower's hybrid, a 100-horsepower motor is used to keep the Green Goat's batteries charged. The locomotive then runs off battery power.

U.S. giant testing Canadian locomotive

Hybrid has potential to cut emissions

BY KEITH McARTHUR
TRANSPORTATION REPORTER

North America's largest railway is testing the prototype of a hybrid locomotive designed by **RailPower Technologies Corp.**, a Vancouver company with just six employees.

The diesel fuel/battery hybrid — marketed as the Green Goat — has the potential to reduce emissions in low-horsepower locomotives used to move freight around rail yards, says Mike Iden, the general director of locomotive engineering and quality at Union Pacific Railroad.

Mr. Iden says Union Pacific will be looking to replace its 700 yard locomotives — also known as switchers or goats — over the next five to 10 years. If the Green Goat performs well in a one-year trial run, he says, it could be just what Union Pacific needs to replace its aging switchers while meeting tougher emissions standards.

"It does have the potential for energy reduction in terms of the amount of fuel that you use and a resulting reduction in emissions . . .

"I'm not . . . saying we're going to go out and buy 700 Green Goats, but that is potentially part of a market that could exist for this technology."

Mr. Iden says Union Pacific is also looking at a number of other suppliers for its replacement switchers. But if the Green Goat lives up to expectations, the potential market for the hybrid could go well beyond Union Pacific, a division of Bethlehem, Pa.-based **Union Pacific Corp.**

Len Cocolicchio, a spokesman for Calgary-based **Canadian Pacific Railway Ltd.**, says the entire rail industry is closely watching the Union Pacific trial.

"Whether this develops into more than interest will, of course, depend on the results of the [Union Pacific] tests. The [Union Pacific] tests will shed light on the environmental benefits of the technology, the longer-term operating performance, and capital and operating costs."

Mark Hallman, a spokesman for Montreal-based **Canadian National Railway Co.**, says CN is prepared to look at the Green Goat. But the railway's fleet of yard switchers is relatively new. As a result, he says, the company is focusing its efforts to reduce emissions on its mainline locomotive fleet.

The Green Goat uses similar technology to that used in hybrid cars such as the Toyota Prius.

Yard switchers typically run on 2,000-horsepower motors. But with lots of stopping and starting in the rail yards, switchers rarely ever run at their maximum output. That means a lot of wasted fuel.

In the Green Goat, the large motor has been replaced with a small, 100-horsepower motor, which is used to keep its batteries charged. The Green Goat then runs off the battery power.

Gerald Koldyk, RailPower's president and chief executive officer, says the Green Goat could use about 30 per cent less fuel than a traditional yard switcher, which could result in an 85-per-cent reduction in oxides of nitrogen, a precursor to smog.

Mr. Koldyk says it cost RailPower about $1-million (U.S.) to develop the prototype. He says that if the Green Goat goes into production, it should retail for about $600,000. The company is looking for a manufacturer in Mexico or Canada.

If the Green Goat takes off, RailPower has more ambitious plans. The company hopes its version of a natural gas locomotive will allow it to expand into supplying locomotives for mainline work.

RailPower's shares closed down 10 cents (Canadian) Friday to $2.10 on the TSX Venture Exchange.

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THE WALL STREET JOURNAL.

WEDNESDAY, OCTOBER 23, 2002 - VOL. CCXL NO. 81 - ★★★ $1.00

Train Makers Race Clock to Find Ways to Cut Locomotive Pollution

By Pat Maio
Dow Jones Newswires

ROSEVILLE, Calif.—A locomotive winding its way through a mountain pass with a plume of smoke trailing behind makes for a picturesque scene, but something ominous lingers in that smoke: nitrogen oxide, a chemical compound that is a major cause of smog and acid rain.

The Environmental Protection Agency established in 1995 an aggressive timetable for the rail industry to reduce emissions of nitrogen oxide. By 2005, the EPA wants a 62% reduction from readings taken during the mid-1990s.

Facing this deadline, railroads, locomotive manufacturers and others are experimenting with technologies to lower the amount of polluting gases and particulates generated by trains. The efforts are aimed at Southern California—the smoggiest region of the nation—where railroads have agreed to introduce less-polluting locomotives first.

In a Union Pacific Corp. rail yard here in Northern California, near Sacramento, RailPower Technologies Corp. is developing one of the more closely watched technologies, a hybrid electric-and-diesel locomotive it calls the Green Goat.

RailPower, Vancouver, British Columbia, says the Green Goat can reduce nitrogen oxide and particulate emissions 85% and decrease fuel consumption 35%.

For now, the Green Goat's only application is in rail yards, which are often prime collecting spots for pollution because a large number of trains move slowly through a confined area.

The Green Goat is a so-called switcher, a locomotive used to move train cars from one track to another in a rail yard. Switchers are considered the biggest polluters in rail yards. Most switchers are 30 to 50 years old and run on small, 1,500- to 2,000-horsepower engines. This class of aging locomotives may prove most challenging for the industry to clean up.

The Green Goat gets its energy from a bank of 30 custom-designed lead-acid, 20-volt batteries that drive the traction motors on its axles. The lead-acid batteries are kept charged by a small generator driven by a 130-horsepower diesel-fueled truck engine. That engine automatically turns off when idling, producing much of the Green Goat's fuel-consumption savings.

RailPower began developing the Green Goat two years ago by dismantling a 1,750-horsepower diesel engine from a 1950s-era switch locomotive. Everything above the frame was tossed out, except the front and rear noses of the locomotive. The batteries, which have been designed to be used for 10 years, take up the majority of the space under the front nose, with a small compartment in the rear for the truck engine and generator.

Some rail executives view the lead-acid batteries as an environmental drawback, with disposal a particular problem.

Frank Donnelly, chief technology officer at RailPower, estimates the Green Goat could cost $600,000 when it goes into production, compared with $1.5 million to $2 million for most locomotives.

Mike Iden, Union Pacific's general director of locomotive engineering, said the RailPower switchers will be tested for a year in the Roseville rail yard. He said they could figure into the Omaha, Neb., company's plans to replace hundreds of aging switchers throughout its system during the next decade.

While tests show promising results, RailPower isn't the only game in town.

General Motors Corp.'s Electro-Motive Division in LaGrange, Ill., is looking at fuel-cell powered locomotives that are nonpolluting, noiseless, fuel-efficient and don't require recharging. But industry observers say GM faces the challenge of shrinking the fuel cells, because current designs would create locomotives too big to fit through tunnels.

General Electric Co.'s Transportation Systems business in Erie, Pa., is experimenting with combinations of less-polluting diesel fuels and batteries that store surplus heat from braking systems that can later be recovered as electrical power used to run a locomotive's engine.

GE is investigating other emissions-reducing products, including locomotives that use automatic start-stop systems to prevent fuel waste while idling.

Whichever technology prevails, it will be rolled out first in Southern California. Four years ago, Union Pacific and Burlington Northern Santa Fe Corp., Fort Worth, Texas, agreed to a plan presented by the California Air Resources Board that holds the railroads responsible for introducing the cleanest of their locomotives in Southern California first.

California is a major rail hub for moving goods from West Coast ports. Union Pacific estimates an average of 52 of its trains enter and leave the state each day. Burlington Northern counts an average of 670 trains a week in the state and has about 250 locomotives in Southern California at any time.

Locomotives are among the largest emitters of nitrogen oxide in Southern California, behind automobiles and diesel trucks, said Sam Atwood, a spokesman at the South Coast Air Quality Management District. The air-quality district is a quasigovernmental agency in Southern California that is responsible, along with the air-resources board, for making sure rail companies carry through on promises to introduce their cleanest locomotives in the region.

Roxanne Johnson, the EPA's environmental-protection specialist in San Francisco, is monitoring the industry's efforts in the West and says she is confident the railroad companies are moving forward to meet emissions goals in a timely fashion.

The railroads face an economic challenge to meet the EPA standards. While gearing up to buy locomotives to meet the emissions standards, they also have to buy locomotives for rail-line growth.

Beginning in 2005, Burlington Northern might be forced to park some locomotives in Barstow, Calif., near the Nevada border, and permit only those engines that meet the air-quality standards to travel westward, said Mark Stehley, assistant vice president in charge of technical research and environmental issues at Burlington Northern.

No one seems to have a handle on the expense associated with complying with the EPA rules.

Ken Hoexter, a Merrill Lynch & Co. transportation analyst, said it is "difficult to quantify in terms of cost" because of the shifting technologies under consideration.

Lawrence Kaufman, a longtime rail columnist with trade publications Trains and Rail Business, says he thinks the railroads may be forced to spend billions of dollars first on replacing the switchers, because they are considered the most-polluting locomotives.

Executives at Union Pacific and Burlington Northern said they are in compliance with current EPA rules, but decisions on spending in future years for less-polluting models will depend on growth over existing rail lines, and what technology comes along to upgrade—or replace—engines when the time comes.

The Environmental Protection Agency established in 1995 an aggressive timetable for the rail industry to reduce emissions of nitrogen oxide. By 2005, the EPA wants a 62% reduction from readings taken during the mid-1990s.

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HYBRID'S WORKING ON THE RAILROAD

Green Goat electric switching locomotive shows promise of hybrids for rail; can be powered by diesels or microturbines

By Bill Siuru

Hybrid electric vehicles ranging from cars and SUVs to buses and trucks are a hot topic in the automotive world. Taking that concept several steps up in horsepower, RailPower Technologies Corp. in Vancouver, B.C., Canada, has developed and successfully demonstrated a hybrid electric yard switching locomotive, dubbed the Green Goat, that features batteries that are charged by a diesel-powered generator set.

Starting in March 2000, RailPower Technologies converted a 1950s vintage EMD GP9 switcher formerly used by Southern Pacific Railways. The 1750 hp Electro-Motive diesel was replaced by a 6.0 L Daewoo diesel engine and 30 custom-designed, 20 V lead acid batteries. Everything above the frame was discarded except for portions of front and rear noses. All other components, including the locomotive control stand, trucks, wiring, and 26L brake system and Electro-Motive switchgear were remanufactured to "like-new" condition.

RailPower Technologies also developed new power electronics, as in the future, the reciprocating diesel engine may be replaced by a diesel-fueled microturbine, such as Capstone's 60 kW microturbine.

Bill Siuru, PhD, PE, is an independent technical journalist based in San Diego, Calif.

RailPower Technologies has developed the Green Goat hybrid electric switching locomotive that incorporates a small diesel engine or microturbine driving a generator that charges a battery bank.

The Green Goat is a series hybrid in that diesel or microturbine generator is only used to keep the batteries charged. The batteries in turn supply electrical energy to the existing traction motors. While 2000 hp is available, the Green Goat normally operates at a maximum of 80 percent of its rated capacity. Since the prime mover only needs to keep the batteries charged, it runs under constant load and at constant speed so it can be sized and "tuned" for most efficient operation. The Green Goat is much quieter, and most importantly uses less fuel and produces lower emissions than a conventional yard switcher. Fuel economy improvements of as much as 35 percent are expected, with about a 90 percent reduction in both nitrogen oxides and particulate matter emissions, the company said.

The system also promises lower maintenance requirements and a significantly lower capital investment, while still using diesel fuel, which means no change in the fuel infrastructure.

While this hybrid technology could be used on other types of locomotives including those used in commuter train service, it is particularly suited for switcher applications.

Frank Donnelly, RailPower's chief technology officer said that, "switchers

continued on page 60

The Association of Equipment Manufacturers will hold its annual product safety seminar with the theme: "Safety is Not an Event — It's a Culture" on January 21-23, 2003 at the Hyatt Regency Union Square in St. Louis, Mo. Keynote speaker will be Mike Gagel, the safety officer at the World Trade Center site for the first 100 days of clean-up following the September 11th attacks.

According to estimates by the **Outdoor Power Equipment Institute**, twelve month shipments of snow thrower products for the 2002 model year showed a increase of 34.9 percent over model year 2001. The 2002 model year indicated that shipments for snow throwers were 820,000 compared to 608,000 for model year 2001.

Sisu Diesel of Finland has selected **Stanadyne Corporation's** Fuel Manager diesel fuel filter and water separation units for both the pre- and final diesel fuel filtration systems on its Tier II engines. Stanadyne has had a long partnership with Sisu Diesel, which now is extending the Fuel Manager to its final filtration application needs after having used the system several years for prefiltration.

Mack Boring & Parts Co. is proud to announce that it is now an authorized distribution center for **Rotary Power Marine Corp.** Mack Boring is authorized for distribution on the East Coast north of Georgia to Maine, in the Great Lakes states and Kentucky and Tennessee.

Clean Seal has formed a strategic partnership with **EPHA** of Hermiston, Oregon, to market EPHA's entire product line, including their recently released Select-A-Loom. EPHA manufactures products designed to protect hydraulic hoses against damaging abrasion.

ASME International has announced its 2003 online continuing education program for Spanish-speaking engineers. The company will offer eight online courses including three new courses, in the Spanish language. The courses are Vibration Analysis and Predictive Maintenance, ASME B 31.1, Code on Power Piping, Nondestructive Testing, ASME Section IX and Reliability-centered Maintenance. The courses in Spanish are Selection and Pump Operation for Petroleum Facilities, ASME B 31.3 Code on Process Piping and ASME 31.8 Code on Gas Transmission and Distribution Piping Systems.

spend a very high percent of their time in idle. Only one percent of their daily life is in the eight notch."

Locomotive engineers may also appreciate the view offered by the Green Goat, as it offers a much lower profile for the hood over the bank of batteries, resulting in improved visibility in all directions. The batteries take up the majority of the space under the long hood, with a small space left over for the engine and generator. The batteries are heavy enough to provide the needed traction.

The first Green Goat demonstrator was built at RailPower's New Westminster Tech Centre and now runs at Southern Railways' yards in New Westminster, British Columbia. More recently, it was announced that the Union Pacific Railroad has signed a one-year demonstration lease for a Green Goat yard switcher that will be based at Union Pacific's yards in Roseville, near Sacramento, Calif.

Michael E. Iden, general director, Car and Locomotive Engineering, Union Pacific Railroad, said, "Union Pacific is constantly looking at ways to operate more cost effectively and to improve the environment by reducing locomotive exhaust emissions. The Green Goat switcher offers the opportunity for substantial operating cost advantages through lower fuel usage, lower maintenance and higher productivity. Union Pacific has looked at several options for replacing our aging switcher fleet and the Green Goat has the strong advantage of having a capital cost that makes sense to the railroad for a 20-year solution. Importantly, it also has no impact on our fueling infrastructure as both its two generator modalities — conventional engine and microturbine use standard diesel fuel."

RailPower President, Gerard Koldyk, stated, "The Green Goat was created to provide a long term superior economic solution for yard switching that would also meet and exceed all the existing and contemplated North American emissions requirements for the railroads. Our strategy is to focus on the immediate markets of environmental sensitivity in California, Texas and New York and then broaden out to general fleet operations and industrial applications."

Koldyk added that the locomotive will be built by one of the several subcontractors.

RailPower Technologies has a U.S. Patent and Trademark for its Green Goat yard switcher technology. In the future, when the technology, economics and supporting infrastructure is sufficiently mature, the microturbine could be replaced by fuel cells which would produce virtually no pollution, just hot water.

In another project, RailPower Technologies is developing a Compressed Integrated Natural Gas Locomotive or CINGL. Here, the large diesel engine is replaced by a much physically smaller recuperated industrial turbine such as a 5500 hp Solar or a 9000 hp Rolls Royce 601 turbine. The natural gas is stored at 4000 psi in 44, 40-ft. long cylinders that hold the equivalent of 5500 gal. of diesel fuel or up to 55 cylinders for the equivalent of 7000 gal. of diesel.

The first case will provide 40 hours of medium-duty cycle operation, the same as a conventional diesel locomotive. By using a high-speed alternator, there is further space savings because a transmission is not needed. With a thermal efficiency of 40 percent, the Green Goat is substantially more efficient than diesel-powered systems. The CINGL's efficiency is also significantly better than the turbine-powered locomotives that were tried by Union Pacific in the 1950s and 1960s, but were dropped because they were not economically competitive.

According to RailPower Technologies, the CINGL can be built with as much as 10,000 hp. The CINGL technology eliminates 99 percent of harmful NO_x and particulate matter. A study done by Rolls-Royce and AlliedSignal concluded that the CINGL locomotive would save the railroads 27 to 33 percent over its lifetime in ownership and operating costs. The CINGL is patented with the preliminary design complete and U.S. Class 1 railroads have shown interest. The project still requires a strategic alliance with a gas turbine manufacturer. ★

THE VANCOUVER SUN

BUSINESS BC

• MONDAY, JANUARY 6, 2003 •

North Van firm designs cleaner locomotive

Engine uses batteries and diesel for power

A prototype engine designed by North Vancouver railway engineer Frank Donnelly to combat air pollution from diesel locomotives is entering its final trials with U.S. rail giant Union Pacific Corp.

U.S. rail companies are under notice to cut down on emissions of nitrogen oxide from their fleets of diesel locomotive by 2005.

In 1995 the federal Environmental Protection Agency gave the industry 10 years to reduce emissions of the gas that causes acid rain and smog by 62 per cent.

A number of companies are vying for the opportunity to provide the rail industry with new technology to combat air pollution.

Donnelly's company RailPower Technologies Corp. based in North Vancouver has developed a hybrid electric-diesel engine — named the Green Goat — that can be used to switch train cars from one track to another in a rail yard.

These switching locomotives cause particularly large emissions of nitrogen oxide as they are usually powered by old and inefficient diesel engines.

Donnelly's technology uses a small diesel generator to feed power to a huge bank of batteries that in turn power the locomotive.

"It's not a new idea — diesel-electric locomotives been around since the Fifties — but no one's ever built something like this," said Donnelly who was in Union Pacific's Roseville, Calif., rail yard where the initial tests are taking place.

The Green Goat uses a 130-horsepower diesel truck engine as a generator to keep the batteries charged. These batteries provide 2,000 horsepower to the locomotive.

The 30 AGM batteries (sealed units that use an absorbent glass mat and are much lighter than lead-cell batteries) are 30 feet long and six feet wide and fill most of the fore part of the locomotive.

Donnelly converted a 50-year old diesel locomotive into the Green Goat by removing most of the structure above the wheels and bed.

He estimates that the Green Goat could cost about $600,000 US if it went into production compared with $1.5 to $2 million for a new diesel locomotive.

The Green Goat will be moving to Union Pacific's rail yards in Chicago for its final tests.

"We've found we're getting 85 per cent reduction in nitrogen oxide and a 30 per cent reduction in [diesel] fuel," said Donnelly.

This sort of engine could be used in some special commuter applications like the Westcoast Express, he said, but it's main function is to replace the fleets of old switching engines now in use all over North America.

"In yard service the locomotive will run indefinitely and so far we've been able to do everything they've asked us to do (during trials)," said Donnelly.

John Bromley, an official with Union Pacific based in Chicago, said it was too early to judge whether the Green Goat would answer the company's need for a non-polluting yard locomotive.

"But we think it holds promise which is why we are moving it to our Chicago yard for further tests," said Bromley.

Chicago Tribune

SECTION 5

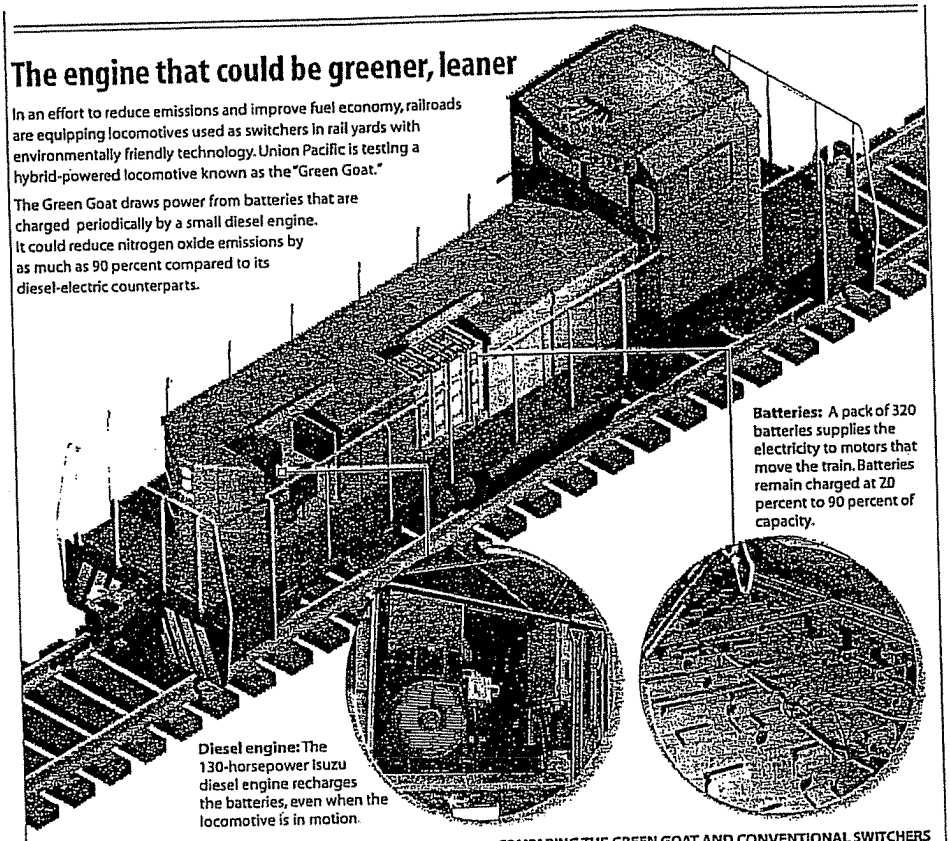
BUSINESS

SUNDAY
APRIL 6, 2003

The engine that could be greener, leaner

In an effort to reduce emissions and improve fuel economy, railroads are equipping locomotives used as switchers in rail yards with environmentally friendly technology. Union Pacific is testing a hybrid-powered locomotive known as the "Green Goat."

The Green Goat draws power from batteries that are charged periodically by a small diesel engine. It could reduce nitrogen oxide emissions by as much as 90 percent compared to its diesel-electric counterparts.



Batteries: A pack of 320 batteries supplies the electricity to motors that move the train. Batteries remain charged at 20 percent to 90 percent of capacity.

Diesel engine: The 130-horsepower Isuzu diesel engine recharges the batteries, even when the locomotive is in motion.

Yard locomotives try to clean up act

By James P. Miller
Tribune staff reporter

America's railroads are under pressure to reduce the tons of pollution their locomotives spew daily and to cut their fuel expenses as well. Can they do it?

With the help of the "Green Goat" and another clean-diesel technology being field-tested in Chicago rail yards, the rail industry says it thinks it can ... it thinks it can ... it thinks it can.

At Union Pacific Corp.'s Proviso Yard in suburban Melrose Park, a score of red and yellow locomotives stand outside a sprawling maintenance and repair building, their mammoth engines idling. "They break 'em, we fix 'em," a hardhatted worker hollers cheerfully over the roaring whine.

It will be many hours, perhaps a day, before the waiting engines chuff into the building to be serviced. While they wait, their engines will run continuously. The sound they generate is so loud that it is painful to stand near them. They stink, too. Despite a stiff breeze out of the north, the oily smell of diesel fumes hangs everywhere.

Twenty yards away, a different engine is preparing to go to work. It is as powerful as the conventional engines nearby. But instead of the mechanical howl of a big diesel, it emits only a modest, intermittent rumble. And instead of a blue-tinged pall of hot diesel smoke, the prototype locomotive known as the "Green Goat" issues an insignificant exhaust plume from time to time. The goat's air brakes release with a whoosh, and then the locomotive glides soundlessly away.

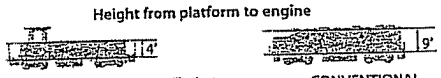
Only a few miles away, at the Burlington Northern and Santa Fe Railroad yard in Cicero, the scene is not greatly different. Trains pull into the yard loaded with intermodal containers; heavy trucks belch black smoke as they carry the containers away. Near the roundhouse sits a covey of unmanned locomotives, engines thrumming. "This is what it sounds like up close," shouts locomotive foreman

PLEASE SEE ENGINES, PAGE 6

COMPARING THE GREEN GOAT AND CONVENTIONAL SWITCHERS

The hybrid battery compartment's low height provides the operator with a less obstructed view, compared to a conventional locomotive.

Height from platform to engine



GREEN GOAT	Train type	CONVENTIONAL
260,000	Weight (pounds)	267,000
52'	Length	59'
14'6"	Height	15'
10'6"	Width	10'
2,100 gallons	Fuel capacity	2,600 gallons
$600,000	Cost	$1,000,000
18 gallons	Average daily fuel usage	250 gallons

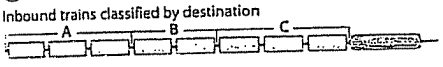
THE ROLE OF THE SWITCHER IN A RAIL YARD

Road locomotives pull rail cars long distances, but when trains reach the rail yard, a fleet of locomotives called switchers takes over, separating and connecting cars to others bound for the same destination.

CLASSIFICATION YARD

(1) Cars that arrive at rail yards are grouped by destination.

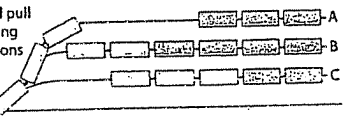
Inbound trains classified by destination



DEPARTURE YARD

(2) The Green Goat moves cars into a departure yard where the train is being assembled to go to different cities.

The goat could pull 25 cars, weighing between 800 tons to 3,000 tons combined.



Sources: Union Pacific Railroad and Railpower Technologies Corp.

Photos by Terrence Antonio James and Associated Press
Chicago Tribune/ Melissa Nagy Deegan and Dionisio Muñoz

ENGINES: EPA backs trials, wants pollution cut

CONTINUED FROM PAGE 1

Jack Frank.

"Park one of these at the edge of the yard near a neighborhood, and they're going to hear it all night. They're going to get irate," he says, clearly familiar with that particular issue.

Frank swings up onto the catwalk that runs along the edge of the locomotive about 5 feet above the ground. Opening a door-sized panel, he turns on a diesel motor the size of a small dresser; this is the "Kim Hotstart" unit that has been retrofitted onto the 25-year-old locomotive. Walking forward to the engineer's cabin, Frank shuts down the main engine. As the big engine's sound abruptly cuts off, the modest buzz of the small motor becomes audible.

"It's a win for everybody," says the mustachioed manager, smiling. "Uses less fuel, makes less pollution, runs quieter."

At rail terminals across America, switcher locomotives—known in railroad slang as "goats"—spend 16 hours or more every day butting railcars into position, herding strings of boxcars to the proper site, and generally keeping things on track so the mile-long trains they assemble depart on time.

Because big diesels are often hard to start, particularly when the air temperature drops below 40 degrees, it's standard practice to constantly keep their 2,000-horsepower engines idling, even though they're only called on intermittently.

Running the engines all day solves the start-up problem, but it's also a big reason why rail centers are so noisy, and why their air is so frequently polluted. The average yard locomotive burns through an estimated 25,000 gallons of diesel fuel each year, and in the process pumps about 5 tons of pollutants into the atmosphere, according to Environmental Protection Agency estimates.

That could be changing. Burlington Northern and Union Pacific are each conducting extensive trials on locomotive formats that appear likely to cut emissions by as much as 90 percent.

Initial results have been positive in both trials.

Railroad officials are focused on cutting their fuel bills, while environmentalists like the prospect of a drastic drop in the engines' output of smog-producing nitrogen oxides, soot particles and carbon monoxide.

"The beauty of it is that, from our perspective, we see a lot of emission-reduction potential, and from the industry point of view it's reducing costs," says Francisco Acevedo, environmental engineer with the EPA's Chicago office.

The Chicago hotstart technology test involving BNSF and the Wisconsin & Southern Railroad is being sponsored as a demonstration project by the EPA. The Hotstart system uses a straightforward concept: If locomotives are left running in order to avoid starting problems, finding another way to keep the engine warm would allow the engines to be shut down whenever they're not being used.

Tribune photo by Terrence Antonio James

Brian Allen, field service technician for Charles Equipment Co., works on a hotstart device at the BNSF rail yard in Cicero, where the EPA is sponsoring a demonstration project on the technology.

The equipment made by Spokane, Wash.-based Kim Hotstart Manufacturing Co. draws the locomotive engine's cooling water and lubricating oil past a heating unit, using a small engine that can easily be fitted alongside the existing engine.

Based on tests that began last September, BNSF calculates that the hotstart system is reducing fuel use by 15 percent to 20 percent, depending on how much time the locomotive idles.

In general, "we're saving about 7,000 gallons of fuel yearly, per locomotive," says Mark Stehly, assistant vice president for BNSF's Railroad Environmental and Research and Development department.

Omaha-based Union Pacific first tested the Green Goat at a facility in California, then brought the experimental locomotive to Chicago last autumn to see how it performs in colder weather.

Made by Railpower Technologies Corp. in Vancouver, the prototype engine is a battery-diesel hybrid, similar in concept to the gas-electric hybrid automobiles entering the consumer market.

The goat's operating power is provided by a 50,000-pound pack of batteries, which allows it to do the same amount of pushing and pulling as a standard diesel locomotive. The batteries are charged by a 130-horsepower diesel engine that kicks on periodically. The result: The goat chews through 30 percent less fuel than a standard yard locomotive.

The test engine's obvious environmental friendliness is a "side benefit," but the key to the tests is whether the goat generates a financial advantage to the company, says Michael E. Iden, Union Pacific's director of locomotive engineering.

The field trial, which looks promising so far and is set to run until early summer, represents the logical next step in Union Pacific's years-long effort to develop alternative fuel technology, Iden says.

The railroad spent three years testing liquid natural gas as an alternative to diesel fuel, for example, but finally shelved the concept when it couldn't resolve certain technical problems. While non-polluting hydrogen fuel-cell technology may someday provide a viable diesel alternative, that option is "nowhere near being ready for prime time," Iden says.

Road locomotives substantially outnumber yard locomotives, but there's logic to the industry's effort to wring savings from rail-yard goats.

For one thing, road engines don't spend much time idling because they're generally running from point to point. For another, EPA rules have drastically limited the pollution output of locomotives manufactured since the start of the year 2000, and in 2005 an even tougher mandate is set to take effect.

The oldest and worst-polluting engines are generally found in the rail yard.

When railroads decide to invest in big-ticket new equipment, they generally focus on upgrading their fleet of cross-country "road units." As a result, those locomotives, which boast 3,000 or more horsepower and are used for long-distance hauling, are the youngest and most efficient engines in a railroad's fleet.

Because locomotives often last 30 years or more, and because road engines that are too old for long-haul chores are often shunted to yard work, the oldest and worst-polluting engines are generally found in the rail yard.

Union Pacific has about 5,000 road locomotives, compared with about 2,000 yard engines. Tellingly, it's replaced about a third of its road fleet since 2000 but hasn't purchased yard engines for many years.

The Omaha rail giant will, out of necessity, be buying hundreds of rail-yard goats in coming years, says Iden, but it's "too soon" to say whether or not they'll be Green Goats.

DEMONSTRATION LEASE AGREEMENT dated 23 May 2003.

BETWEEN Pacific Harbor Line, Inc., a corporation having a place of business at 340 Water Street, Wilmington, California, 90744, United States of America (hereinafter referred to as "PHL")

AND RailPower Technologies Corp., a British Columbia company having a place of business at Suite 202 – 50 Fell Avenue, North Vancouver, British Columbia, Canada V7P 3S2, (hereinafter referred to as "RAILPOWER")

WHEREAS

A. RAILPOWER has designed and built a hybrid power switching locomotive known as the "Green Goat", whose locomotive reporting marks are RPRX 2001 and has patented same;

B. PHL wishes to evaluate the suitability and business case of the Green Goat in actual freight railway field conditions on its facilities in Southern California;

C. Commercial demonstration needs to be undertaken to confirm various factors of the features and benefits of the Green Goat in order to validate the business case for the future needs of PHL;

This Agreement sets forth the mutual agreement of the parties as follows:

1. SCOPE AND PURPOSE

1.1 The purpose of this agreement is to establish the principles upon which PHL and RAILPOWER will demonstrate the Green Goat switching locomotive,

1.2 Nothing in this agreement shall commit PHL in any manner to purchasing any locomotives or other services from RAILPOWER. Should any such transaction arise from this demonstration, the parties will execute new agreements to replace this agreement.

2. ACTION PLAN

2.1 PHL and RAILPOWER shall determine a demonstration protocol that meets the requirements of PHL for evaluation and meets RAILPOWER'S requirements for use of the Green Goat. When completed and signed by both parties it will be labelled Appendix "A" and when attached hereto shall form part of this agreement. Appendix "A" will define the demonstration and will include the following items:

(a) confirmation of the location as PHL's premises in Wilmington, California, USA or arrangement of alternate site;

(b) methodology for RAILPOWER personnel to interact and interface with PHL and its personnel during the demonstration; and

(c) ability of the Green Goat to perform PHL's required duty cycles.

2.2 RAILPOWER shall deliver the Green Goat to PHL in mid-July. Prior to delivery RAILPOWER shall perform routine maintenance on the Green Goat and ensure that the Green Goat is drained of fuel and packed for shipping. On delivery to PHL, RAILPOWER employees will ensure that the locomotive is fully operational and that PHL's employees are fully instructed as to the operation of the locomotive.

3. COSTS

3.1 For each available day of service PHL will pay to RAILPOWER the sum of US$150. "Available day of service" shall mean when the locomotive is available to PHL for service and not being repaired or maintained. This will apply to the greater of the duration of the lease period of 30 days or the period from delivery to PHL to return of the Green Goat demonstrator to an interchange point acceptable to both PHL and RAILPOWER, as described in Section 3.5 hereof

3.2 PHL shall pay the costs of fuel, lube oil and all other maintenance items while locomotive is being operated by PHL,

3.3 RAILPOWER will pay for all maintenance caused by equipment or system failure,

3.4 All risk and liability arising from the use of the Green Goat demonstrator by PHL, other than arising from defective design and/or manufacture by RAILPOWER or caused by the negligence or misconduct of RAILPOWER, shall be for the account of PHL and PHL shall indemnify RAILPOWER therefor. The replacement cost for total loss shall be US$650,000, less any salvage value of the unit, if any. All risk and liability arising from design and/or manufacture by RAILPOWER, and caused by the negligence or misconduct of RAILPOWER, or its directors, officers, employees or agents, shall be for the account of RAILPOWER and RAILPOWER shall indemnify PHL therefor.

3.5 RAILPOWER shall deliver the locomotive to PHL at the beginning of the lease at the closest acceptable PHL interchange point at RAILPOWER's expense. RAILPOWER will pay for all costs associated with moving locomotive to/from relevant interchange points. At the end of the demonstration lease the unit will be returned to RAILPOWER by PHL at PHL's expense to the closest appropriate PHL interchange point agreed by RAILPOWER and PHL.

3.6 RAILPOWER will pay for the travel, salary and other costs of its staff to monitor, service, direct service and other matters as required. At PHL's request, RAILPOWER and its agents shall sign PHL's standard releases prior to entering on the property of PHL. At all times that such persons are on PHL property they shall comply with all PHL safety and operating rules and directions by PHL officials.

4. DURATION OF LEASE

The lease will be for a continuous period of 30 days from the date of delivery of the Green Goat to PHL unless extended in writing by mutual agreement by RAILPOWER and PHL.

5. CONFIDENTIALITY

5.1 Except as provided under this clause, each party shall disclose the results of this demonstration only to those employees and professional advisers (including lawyers, accountants and brokers) with a need to know, and shall keep the existence and subject matter of this agreement confidential and shall not make any public announcement or disclose to any third party without the prior consent of the other party unless required by law or the TSX Venture Exchange. The parties specifically agree that RAILPOWER will issue a mutually agreed news release announcing this agreement. All information disclosed between the parties for the purposes of negotiations between PHL and RAILPOWER whether technical or otherwise and in any form whatsoever shall be treated as confidential by the receiving party and protected to the same extent as its own proprietary information. This restriction shall not apply to information that is: -

(a) in the public domain;

(b) already lawfully disclosed without restriction by the disclosing party to a third party; or

(c) subsequently disclosed without restriction by the disclosing party to a third party.

5.2 By mutual agreement, RAILPOWER and PHL will set up opportunities to demonstrate the Green Goat to press, environmental and other interested parties to showcase PHL and RAILPOWER's commitment to superior operating economics and a cleaner environment.

6. GENERAL

6.1 This agreement constitutes the entire Agreement between the parties and supersedes any prior negotiation, understandings, and agreements between the parties respecting the subject matter hereof. Modifications to this agreement must be in writing and signed by duly authorized representatives of each party.

6.2 This agreement may not be assigned in whole or in part by either party without the prior written consent of the other.

6.3 This agreement shall be governed by the laws of British Columbia and the laws of Canada applicable therein.

IN WITNESS WHEREOF the parties have executed this agreement with effect on the date first above written.

PACIFIC HARBOR LINE, INC.

Per: _____
Print Name: ANDREW FOX
Title: President

RAILPOWER TECHNOLOGIES CORP.

Per: _____
Print Name: SIMON P. CLARKE
Title: EXECUTIVE V.P, CORPORATE DEVELOPMENT

APPENDIX "A"

This appendix defines the scope of the demonstration of the Green Goat with PHL (the "Demonstration").

1. The Demonstration will take place at PHL's premises in Wilmington California;

2. PHL will allow RAILPOWER personnel to monitor the progress of the Demonstration and will provide required access to RAILPOWER personnel for such purposes, provided such RAILPOWER personnel comply with all of PHL's rules and requirements;

3. RailPower personnel shall instruct PHL personnel in the operation of the Green Goat Demonstrator and will be available throughout the duration of the Demonstration to assist with the Demonstration and any issues that might arise;

4. PHL shall use the Green Goat Demonstrator in its regular switching services in order to ascertain the ability of the Green Goat Demonstrator to perform PHL's required duty cycle and to generate the required tractive effort;

5. The Demonstration will also be used to compare the fuel consumption of the Green Goat Demonstrator to the existing PHL locomotives under the same service conditions. Exactly how such tests will be performed will be agreed between RailPower personnel and PHL personnel;

6. PHL shall also closely monitor any maintenance issues that might arise on the Green Goat Demonstrator and any time that the Green Goat Demonstrator is out of service. RailPower personnel shall be contacted should any issues arise and will oversee any maintenance required; and

7. RailPower will provide PHL with emissions data relating to the Green Goat Demonstrator and will work with PHL to provide all necessary information to PHL or necessary 3rd parties.

APPENDIX C

Patent Application 5107-3-CIP
Claim elements v. Date of invention

"FD" is Frank Donnelly

Claim element	Date this feature was first incorporated into the leased locomotive
Claim 1. A locomotive, comprising: a plurality of direct current traction motors	FD October 1999
corresponding to a plurality of axles and a plurality of drive switches; and	FD October 1999
a plurality of free-wheeling bypass circuits,	FD October 1999
each bypass circuit bypassing a corresponding one of the plurality of plurality of drive switches.	FD October 1999
2. The locomotive of claim 1, further comprising: a plurality of chopper circuits	FD October 1999
corresponding to the plurality of direct current traction motors	FD October 1999
each chopper circuit comprising a respective free-wheeling bypass circuit and drive switch in electrical communication with a respective direct current traction motor.	FD October 1999
3. The locomotive of claim 2, wherein, in a first mode, at least most of the electrical current passing through the chopper circuit passes through the corresponding free-wheeling bypass circuit and the corresponding traction motor and bypasses the corresponding drive switch	FD October 1999
and, in a second mode, at least most of the electrical current passing through the chopper circuit passes through the corresponding drive switch and traction motor and bypasses the corresponding free-wheeling bypass circuit.	FD October 1999
4. The locomotive of claim 3, wherein, during a selected time interval, a first chopper circuit corresponding to a first traction motor is in the first mode and a second chopper circuit corresponding to a second traction motor is in the second mode.	FD October 1999
5. The locomotive of claim 1, wherein each free-wheeling bypass circuit comprises a free-wheeling gate.	FD October 1999

6. The locomotive of claim 1, further comprising: a controller operable to (a) determine the power requirement for each motor at each of a number of successive time intervals;	FD October 1999
(b) determine the necessary voltage and pulse width to achieve the desired power for each motor;	FD October 1999
and (c) sequentially pulse power to each of the motors for a duration necessary to achieve the power requirement at each successive time interval.	FD October 1999
7. The locomotive of claim 6, wherein, during a selected time interval, a first traction motor receives a first power pulse and a second different traction motor receives a second power pulse	FD October 1999
and wherein the first and second power pulses have differing magnitudes.	FD October 1999
8. The locomotive of claim 7, wherein the first and second power pulses are nonoverlapping	FD October 1999
9. The locomotive of claim 8, wherein, when the first traction motor receives the first power pulse, the second traction motor receives no power pulse and, when the second traction motor receives the second power pulse, the first traction motor receives no power pulse.	FD October 1999
10. A method for operating a locomotive, comprising: providing a plurality of direct current traction motors corresponding to a plurality of axles	FD October 1999
and at least one chopper circuit, the at least one chopper circuit comprising a corresponding drive circuit,	FD October 1999
the drive circuit including a corresponding drive switch and being in electrical communication with a corresponding one or more of the plurality of traction motors,	FD October 1999
and a corresponding free-wheeling bypass circuit, the bypass circuit bypassing the corresponding drive switch,	FD October 1999
wherein, in a first mode, at least most of the electrical current passing through the corresponding chopper circuit passes through the corresponding free-wheeling bypass circuit and corresponding one or more of the plurality of traction motors and bypasses the corresponding drive switch and,	FD October 1999

in a second mode, at least most of the electrical current passing through the corresponding chopper circuit passes through the corresponding drive switch and the corresponding one or more traction motors and bypasses the corresponding free-wheeling bypass circuit; and	FD October 1999
during a selected time interval, operating at least one of the traction motors in the first mode and a different at least one of the traction motors in the second mode.	FD October 1999
11. The method of claim 10, wherein the corresponding at least one chopper circuit includes a plurality of respective chopper circuits corresponding to the plurality of direct current traction motors,	FD October 1999
each chopper circuit comprising a corresponding free-wheeling bypass circuit and drive switch in electrical communication with a respective direct current traction motor.	FD October 1999
12. The method of claim 10, wherein each free-wheeling bypass circuit comprises a free-wheeling gate.	FD October 1999
13. The method of claim 10, further comprising: determining the power requirement for each motor at each of a number of successive time intervals;	FD October 1999
determining the necessary effective voltage and pulse width to achieve the desired power for each motor; and	FD October 1999
sequentially pulsing each of the motors for a duration necessary to achieve the power requirement at each successive time interval.	FD October 1999
14. The method of claim 13, wherein, during a selected time interval, a first traction motor receives a first power pulse and a second different traction receives a second power pulse and wherein the first and second power pulses have differing magnitudes.	FD October 1999
15. The method of claim 14, wherein the first and second power pulses are nonoverlapping.	FD October 1999
16. The method of claim 15, wherein, when the first traction motor receives the first power pulse, the second traction motor receives no power pulse and, when the second traction motor receives the second power pulse, the first traction motor receives no power pulse.	FD October 1999

17. The method of claim 13, wherein power is cut and then restored to a first motor, while maintaining at least substantially constant power to the remaining motors, to correct loss of traction on the first motor.	FD October 2000
18. The method of claim 13, wherein over-current protection for each individually controlled motor is provided.	FD May 2001
19. The method of claim 13, wherein power is also provided to all of the plurality of motors constantly at reduced voltage during selected intervals.	FD October 1999
20. The method of claim 13, wherein said power is sequentially pulsed using a pulse width modulation device.	FD October 1999

Patent Application 5107-4
Claim elements v. Date of invention

"FD" is Frank Donnelly, "JW" is John Watson, "BI" is Brian Iwan, "RB" is Ryan Biln

Claim element	Date of invention (please indicate if there are different invention dates within this element)
1. A locomotive, comprising: a plurality of direct current traction motors	FD October 1999
corresponding to a plurality of axles and a plurality of drive switches,	FD October 1999
each traction motor operating in a driven mode and a free-wheeling mode, wherein in the driven mode a power pulse passes through the traction motor and the corresponding drive switch and in the free-wheeling mode the power pulse passes through the traction motor and bypasses the corresponding drive switch; and	FD October 1999
a plurality of filters,	FD December 2001
each filter corresponding to one of the plurality of direct current traction motors, to absorb electrical voltage transients and smooth current ripples through the traction motors resulting from changes between the driven and free-wheeling modes.	FD December 2001
2. The locomotive of Claim 1 further comprising: a plurality of free-wheeling bypass circuits, each bypass circuit bypassing a corresponding one of the plurality of drive switches.	FD October 1999
3. The locomotive of Claim 1, further comprising: a plurality of chopper circuits corresponding to the plurality of direct current traction motors,	FD October 1999
each chopper circuit comprising the free-wheeling bypass circuit, the drive switch being in electrical communication with a respective direct current traction motor, and at least one of the filters.	FD December 2001
4. The locomotive of Claim 3, wherein, during a selected time interval, a first chopper circuit corresponding to a first traction motor is in the first mode and a second chopper circuit corresponding to a second traction motor is in the second mode.	FD October 1999
5. A locomotive, comprising: a plurality of electrical storage subunits,	JW August 2003

wherein in a first mode the electrical storage subunits are connected electrically in series and in a second mode the electrical storage subunits are connected electrically in parallel.	JW August 2003
6. The locomotive of Claim 5 further comprising: at least one switch to switch the electrical storage subunits between the first and second modes.	JW August 2003
7. The locomotive of Claim 5 wherein simultaneously some of the electrical storage subunits are electrically connected in series and others of the electrical storage subunits are electrically connected in parallel.	JW August 2003
8. A locomotive, comprising: a plurality of direct current traction motors in communication with a plurality of axles;	FD October 1999
a prime energy source;	FD October 1999
an energy conversion device, in communication with the prime energy source, to convert the energy output by the prime energy source into direct current electricity; and	FD October 1999
an energy storage device, in communication with the energy conversion device and the plurality of traction motors, to receive and store the direct current electricity,	FD October 1999
wherein the energy storage device comprises a plurality of capacitors operable to store the stored energy.	FD July 2003
9. The locomotive of Claim 8 wherein at least most of the stored electricity is stored in the plurality of capacitors.	FD July 2003
10. The locomotive of claim 9 further comprising a pulse forming network to convert the output of the plurality of capacitors to a form acceptable to the traction motors.	FD July 2003
11. A locomotive, comprising: a plurality of traction motors in communication with a plurality of axles;	FD October 1999
a prime energy source for providing power to the plurality of traction motors; and	FD October 1999
a plurality of air brake systems operatively engaging a respective one of the plurality of axles,	FD October 1999

each air brake system comprising at least one movable braking surface element and corresponding air-brake cylinder and a fluid-activated brake release,	FD June 2002
wherein, when a moveable braking surface element is locked in position against a braking surface, fluid pressure is applied by the fluid-activated brake release to disengage the locked moveable braking surface from the braking surface.	FD June 2002
12. The locomotive of Claim 11, further comprising: an energy conversion device, in communication with the prime energy source, to convert the energy output by the prime energy source into direct current electricity; and	FD October 1999
an energy storage device, in communication with the energy conversion device and the plurality of traction motors, to receive and store the direct current electricity.	FD October 1999
13. The locomotive of Claim 11 wherein each moveable braking surface element comprises a plurality of holes passing therethrough and the fluid-activated brake release forces fluid through the holes in the moveable braking surface element and against the braking surface to form a brake release force.	FD June 2002
14. The locomotive of Claim 13 wherein the force required to unlock a locked braking surface element is the braking force and the release force is at least about 10% greater than the braking force.	FD, JW August 2003
15. A locomotive, comprising: a plurality of direct current traction motors in communication with a plurality of axles;	FD October 1999
a prime energy source;	FD October 1999
an energy conversion device, in communication with the prime energy source, to convert the energy output by the prime energy source into direct current electricity;	FD October 1999
an energy storage device, in communication with the energy conversion device and the plurality of traction motors, to receive and store the direct current electricity;	FD October 1999
a controller operable to control an excitation current to the energy conversion device,	FD May 2001

wherein at least one of the following statements is true: (i) when a first predetermined set point is exceeded by a first monitored parameter, the excitation current is increased and, when a second predetermined set point exceeds the first monitored parameter, the excitation current is decreased and wherein the first monitored parameter is revolutions per minute of a mechanical component of the prime energy source and	FD October 2001
(ii) when the first predetermined set point is exceeded by a second monitored parameter, the excitation current is decreased and, when the second predetermined set point exceeds the second monitored parameter, the excitation current is increased and wherein the second monitored parameter is the output power of the energy conversion device.	FD October 2001
16. The locomotive of Claim 15 wherein the first and second predetermined set points are selected to produce at least a desired degree of fuel efficiency for the prime energy source.	FD October 2001
17. The locomotive of Claim 15 wherein (i) is true.	FD October 2001
18. The locomotive of Claim 15 wherein (ii) is true.	FD October 2001
19. A method for providing electrical energy to an energy storage device in a locomotive, comprising: (a) providing a locomotive comprising: (i) a plurality of direct current traction motors in communication with a plurality of axles;	FD October 1999
(ii) a prime energy source;	FD October 1999
(iii) an energy conversion device, in communication with the prime energy source, to convert the energy output by the prime energy source into direct current electricity; and	FD October 1999
(iv) an energy storage device, in communication with the energy conversion device and the plurality of traction motors, to receive and store the direct current electricity; and	FD October 1999

(b) controlling an excitation current to the energy conversion device by performing at least one of the following steps: (i) when a first predetermined set point is exceeded by a first monitored parameter, the excitation current is increased and, when a second predetermined set point exceeds the first monitored parameter, the excitation current is decreased and wherein the first monitored parameter is revolutions per minute of a mechanical component of the prime energy source and (ii) when the first predetermined set point is exceeded by a second monitored parameter, the excitation current is decreased and, when the second predetermined set point exceeds the second monitored parameter, the excitation current is increased and wherein the second monitored parameter is the output power of the energy conversion device.	FD October 2001
20. The method of Claim 19 wherein the first and second predetermined set points are selected to produce at least a desired degree of fuel efficiency for the prime energy source.	FD October 2001
21. The locomotive of Claim 19 wherein step (i) is performed.	FD October 2001
22. The locomotive of Claim 19 wherein step (ii) is performed.	FD October 2001
23. A locomotive, comprising: a plurality of direct current traction motors in communication with a plurality of axles;	FD October 1999
a prime energy source;	FD October 1999
an energy conversion device, in communication with the prime energy source, to convert the energy output by the prime energy source into direct current electricity;	FD October 1999
an energy storage device, in communication with the energy conversion device and the plurality of traction motors, to receive and store the direct current electricity;	FD October 1999
a controller operable to monitor an operational parameter of each of the plurality of axles and/or traction motors,	FD October 1999
wherein the monitored operational parameter is at least one of revolutions per minute of an axle, an electrical current provided to a traction motor, and a voltage applied to a component of a traction motor.	FD October 1999
24. The locomotive of Claim 23 wherein the controller is operable to control each of the plurality of traction motors independently of the other traction motors.	FD October 1999

25. The locomotive of Claim 23 wherein the controller is operable to decrease power supplied to a first traction motor engaging a first axle without decreasing the power supplied to other traction motors when the revolutions per minute exceed a selected threshold.	FD October 1999
26. The locomotive of Claim 23 further comprising: an air brake assembly located on each of the plurality of axles,	FD June 2002
the air brake assembly comprising one or more brake shoes, an air cylinder, and an fluid-activated brake release.	FD June 2002
27. The locomotive of Claim 25 wherein, when a first air brake assembly is locked in engagement with a first braking surface on a first axle but a second air brake assembly is not locked into engagement with a second braking surface on a second axle,	FD June 2002
the controller is operable to activate a first fluid-activated brake release on the first axle without activating a second fluid-activated brake release on the second axle.	FD June 2002
28. The locomotive of Claim 26 wherein a brake assembly is deemed to be locked when the locomotive is in motion, the air brake assembly is deactivated, and the revolutions per minute on the axle engaging the air brake assembly are at least substantially zero.	FD June 2002
29. A method for controlling the operation of a locomotive, comprising: (a) providing a locomotive, the locomotive comprising: (i) a plurality of direct current traction motors in communication with a plurality of axles;	FD October 1999
(ii) a prime energy source;	FD October 1999
(iii) an energy conversion device, in communication with the prime energy source, to convert the energy output by the prime energy source into direct current electricity; and	FD October 1999
(iv) an energy storage device, in communication with the energy conversion device and the plurality of traction motors, to receive and store the direct current electricity; and	FD October 1999
(b) monitoring an operational parameter of each of the plurality of axles and/or traction motors, wherein the monitored operational parameter is at least one of revolutions per minute of an axle, an electrical current provided to a traction motor, and a voltage applied to a component of a traction motor.	FD October 1999

30. The method of Claim 29 further comprising: controlling each of the plurality of traction motors independently of the other traction motors.	FD October 1999
31. The method of Claim 29 further comprising: decreasing power supplied to a first traction motor engaging a first axle without decreasing the power supplied to other traction motors when the revolutions per minute of the first axle exceed a selected threshold.	FD October 1999
32. The method of Claim 29 wherein the locomotive comprises an air brake assembly located on each of the plurality of axles,	FD June 2002
the air brake assembly comprising one or more brake pads, an air cylinder, and an air-activated brake release.	FD June 2002
33. The method of Claim 29 further comprising: when a first air brake assembly is locked in engagement with a first braking surface on a first axle but a second air brake assembly is not locked into engagement with a second braking surface on a second axle, activating a first fluid-activated brake release on the first axle without activating a second fluid-activated brake release on the second axle.	FD June 2002
34. The locomotive of Claim 33 wherein a brake assembly is deemed to be locked when the locomotive is in motion, the air brake assembly is deactivated, and the revolutions per minute on the axle engaging the air brake assembly are at least substantially zero.	FD June 2002
35. A locomotive, comprising: a plurality of direct current traction motors in communication with a plurality of axles;	FD October 1999
a prime energy source;	FD October 1999
an energy conversion device, in communication with the prime energy source, to convert the energy output by the prime energy source into direct current electricity;	FD October 1999
an energy storage device, in communication with the energy conversion device and the plurality of traction motors, to receive and store the direct current electricity;	FD October 1999
a user interface operable to receive a command from an operator to control a locomotive speed at a specified velocity; and	FD October 1999

a controller operable to control the velocity of the locomotive at or near the specified velocity by performing at least one of the following steps: (i) maintaining a substantially constant power across each of the plurality of traction motors, the power being related to the specified velocity; and (ii) maintaining the revolutions per minute of each of the plurality of axles at a rate related to the specified velocity.	FD October 1999
36. The locomotive of Claim 35 wherein step (i) is performed.	FD October 1999
37. The locomotive of Claim 35 wherein step (ii) is performed.	FD October 1999
38. The locomotive of Claim 35 wherein corresponding power applied across at least two of the traction motors are different.	FD October 1999
39. The locomotive of Claim 35 wherein corresponding revolutions per minute of at least two of the axles are different.	FD October 1999
40. A method for operating a locomotive, comprising: (a) providing a locomotive, the locomotive comprising: (i) a plurality of direct current traction motors in communication with a plurality of axles;	FD, BI February 2002
(ii) a prime energy source;	FD, BI February 2002
(iii) an energy conversion device, in communication with the prime energy source, to convert the energy output by the prime energy source into direct current electricity;	FD, BI February 2002
(iv) an energy storage device, in communication with the energy conversion device and the plurality of traction motors, to receive and store the direct current electricity; and	FD, BI February 2002
(v) a user interface operable to receive a command from an operator to control a locomotive speed at a specified velocity; and	FD, BI February 2002
(b) controlling the velocity of the locomotive at or near the specified velocity by performing at least one of the following steps: (i) maintaining a substantially constant power across each of the plurality of traction motors, the power being related to the specified velocity; and (ii) maintaining the revolutions per minute of each of the plurality of axles at a rate related to the specified velocity.	FD, BI February 2002
41. The method of Claim 40 wherein step (i) is performed.	FD October 1999
42. The method of Claim 40 wherein step (ii) is performed.	FD, BI February 2002

43. The method of claim 40 wherein corresponding power applied across at least two of the traction motors are different.	FD October 1999
44. The method of Claim 40 wherein corresponding revolutions per minute of at least two of the axles are different.	FD October 1999
45. A power control system for a locomotive, comprising: a controller operable to determine an electrical current passing through each of a plurality of direct current traction motors; and	FD October 1999
a graphical user interface operable to provide the electrical current passing through each of the plurality of direct current traction motors to an operator.	BI, RB June 2001
46. The power control system of claim 45, wherein the controller is operable to activate an alarm when the electrical current passing through one or more of the direct current traction motors exceeds a predetermined threshold.	BI, RB June 2001
47. A power control method for a locomotive, comprising: determining an electrical current passing through each of a plurality of direct current traction motors; and	BI, RB June 2001
providing the information of the electrical current passing through each of the plurality of direct current traction motors to an operator.	BI, RB June 2001
48. The power control method of claim 47, further comprising: activating an alarm when the electrical current passing through one or more of the direct current traction motors exceeds a predetermined threshold.	BI March 2001